NATIONAL PETROLEUM NEWS

August 2, 1944

TECHNOLOGY DEPT!

Editor Platt Goes to European War Front To Get the Story of Oil for NPN Readers!

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CLEVELAND—To tell the story first-hand of the vital part that petroleum products are playing in winning the war, NATIONAL PETROLEUM NEWS' editor-in-chief, Warren C. Platt, has gone to the European war theater. He is fully accredited as a battle zone correspondent by the U. S. War Department and will visit many of the combat areas under the same conditions as the regular news correspondents.

His articles, to appear exclusively in NPN, will tell the oil industry of the new and revolutionary methods which are being used for transporting its products at the battle fronts. They will describe the novel methods for servicing air and ground equipment which have been evolved under wartime conditions, some of which will later be adopted in the industry's commercial practices. Editor Platt also will write of the unusual conditions under which petroleum products must perform without breakdown in battle service.

He will write home about many of the oil men who have taken leave of their jobs in this country and are now overseas applying their technological and practical experience of many years with oil companies, to the end that petroleum products may function with all possible efficiency under actual combat conditions.

Precedent in all the annals of business and industrial paper reporting is broken in this wartime assignment accepted by Editor Platt. For its readers, the role that oil is serving in wartime will be reported, not by a special correspondent, not by a staff writer,—but by the chief editor of an oil journal with over 30 years experience writing of the oil industry. In that period he studied the ways in which oil products served in the first World War as well as the many developments in peacetime practices since the inception and growth of the automobile.

Mr. Platt is well-equipped for the task before him. He has been editor of NPN since it was born thirty-five years ago, and as such, has been in constant touch with Industry problems and their solutions. He has watched the Oil Industry grow from infancy to its present important place in World economy.

During the war of 1914-1918 he saw the Industry faced with what was then its severest test. The problems arising out of that war were fully met by the Industry, just as they are, immeasurably multiplied, being met today.

Mr. Platt

At the war fronts, Mr. Platt will meet and talk with men who are finding the solution to armored warfare—the men who are finding a means of supplying the enormous jaws of the greatest war machine in history with sufficient fuel to bring it to victory.

Many of these men are his personal friends, as they are personal friends of their brother oil men doing the job at home. Employing the keyboard of his typewriter, Mr. Platt will, in future issues of NPN, tell you their stories.

Highlights in This Week's NPN—

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MOTORS AND CONTROL

Facts and Flashes

From the
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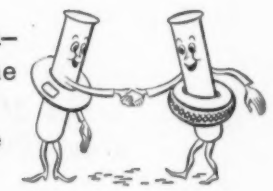
THE MILLIONTH HOUR OF flight training passed a few weeks ago and, celebrated by a training school, brought to light some startling figures in gasoline consumption. To put 16,000 pilots through that number of primary hours of training took 20,000,000 gallons of gasoline—enough to flood a lock of the Panama Canal.

ONE MILLION SYNTHETIC TIRES for passenger cars are being produced each month by the industry. While this is a tremendous achievement on the part of tire manufacturers, this quantity falls far short of prewar production. A-card holders will probably not be able to get new synthetic tires for many months to come.

100% LIQUID FILLING of tractor tires has been made easy and practical by a new pump which removes the air and introduces the liquid in one operation. It takes only half an hour for the operation on even the largest tires. A solution of calcium chloride in water is used to prevent freezing during winter. Liquid solution in tires, because of the increased weight, provides maximum traction, reduces slippage to a minimum and consequently cuts down on wear. In addition, 100 per cent liquid filling prevents pressure loss, and the pressure builds up automatically as the load increases.

SYNTHETIC RUBBER CAN BE RECLAIMED, and already more than a million pounds has been turned back to the manufacture of identical items for which it was originally used. At first synthetic rubber was considered completely expendable. None of the formulas applicable to reclamation of natural rubber would work with synthetic. New formulas and processes, however, have now made it possible to reclaim this product using the same machinery as for natural rubber.



THE AMERICAN ARMY keeps fast-moving troops well supplied with perishable food by use of mobile refrigeration units. Each unit has a capacity of five tons of food and can maintain temperatures as low as ten degrees above zero.

Late Flash

SINCE THE BEGINNING OF THE YEAR Ethyl consumer advertising has been preparing the public for the recently announced "cut back" in the production of premium fuels for civilian use. The "More and More Ethyl is Going Overseas" theme has been featured in leading national magazines.

Burt R. Bay . . .

At Midcontinent Helm For Petroleum 'Naturals'

THE NATURAL GAS AND NATURAL GASOLINE INDUSTRIES have little or no reconversion facing them when the battle front guns cease firing, but there will be a temporary recession in sales of gas to industries during their reconversion, in the opinion of Burt R. Bay, president of Northern Natural Gas Co. and subsidiaries at Omaha, who is also chairman of the Dist. 2 natural gas and natural gasoline committee. Expansion of the two industries is then expected.

Difficulties have been and still are facing the industry in overcoming the shortages of material needed for construction to maintain an adequate supply of products. But on the whole District 2 gas supply is improved over 1943.

Mr. Bay has headed the industry committee since its organization in July, 1942. He is a West Virginian, born at Charleston Aug. 8, 1885, but his parents were Ohioans and soon returned to the Buckeye State. Burt grew up in Cambridge, O., made his way through grade school attended Central Hi, then began his postgraduate course in the "Little Red School House" of practical experience at 16.

His first job was in a tinplate mill; then came a machine and forge shop. The Columbus Natural Gas Co. at Grandville, O., took him on as a machinist in their compression station. This, his first employment in the natural gas industry, was like carrying water for the elephants, for it gained him entrance into the main show. He was made superintendent at Mansfield, then at Wooster for the Columbus and related companies, Medina Gas & Fuel Co., Buckeye State Gas & Fuel Co. and Berea Pipeline Co.

Those properties were later acquired by Cities Service company and late in 1917 Mr. Bay was transferred to Bartlesville, Okla., headquarters of Empire Gas & Fuel Co., another Cities Service subsidiary, where he was superintendent of gas and oil pumping stations. Promotion continued. He became assistant general superintendent of the gas division, then general superintendent.

Having laid the groundwork of knowledge and experience, he went with the Missouri-Kansas Pipe Line Co. at Kansas City as vice-president and general manager in the summer of 1929. Later in the same year Panhandle Eastern Pipe Line Co. was incorporated and he was named vice-president and general manager. He became president in 1933, but in that era of governmental anti-trust suits stepped down to vice-president and general manager again as part of a consent decree.

On Aug. 1, 1938, he joined Northern Natural Gas Co. and subsidiaries as executive vice-president and director, becoming president six months later.

He is a member of the Advisory and Technical Research Committee of the American Gas Assn., and is vice president of the Mid-West Gas Assn.

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BULLETIN

NEW RATIONING FOR MILITARY

WASHINGTON—OPA this week ordered a new gasoline and fuel oil ration system for the armed services, Maritime Commission and War Shipping Administration.

Under the change, OPA form R-544 is abolished and becomes invalid on September 1. The new procedure calls for Army, Navy, Marine Corps and Coast Guard to issue checks on ration bank accounts for bulk deliveries of gasoline and bulk deliveries of fuel oil. This marks the first time that these services have been authorized to open ration bank accounts.

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Truck Tire Crisis Menaces Petroleum Highway Transport

ODT and WPB Scurry to Cushion Blow, Amid Talk of Civilian 'Calamity'. New OPA Panels to Deal Out Thin Quotas

NATIONAL PETROLEUM NEWS
NPN
NEWSMAGAZINE FOR OIL MANAGEMENT MEN

NPN News Bureau

WASHINGTON — The nation was brought face to face this week with a shortage of heavy truck tires so serious that it threatened a "calamitous" breakdown of essential civilian transportation, including over-the-road petroleum operations.

Precipitating the crisis was a WPB order slashing by more than half the number of tires of size 8.25 and larger estimated by ODT to be necessary to meet basic minimum requirements. With an "absolute maximum" of only 73,000 tires available for use during each of the months of August and September, compared with an actual need for 165,000 a month, government agencies acted swiftly, but with tongues in cheek and fingers crossed, to cushion the blow by:

1. Cancelling outright all outstanding ration certificates dated July 15 or earlier for truck and bus tires of size 8.25 and larger.

2. Taking control over the issuance of new certificates from the 5,500 local rationing boards and placing it in the hands of special emergency truck tire rationing panels, one of which is being set up in each OPA district.

3. Establishing a priority and preference list of six classes of heavy tire users, on which all petroleum trucking operations save retail deliveries of gasoline and fuel oil received a top, No. 1 rating. Although local delivery oil trucks were given a rating of 2B—only two removed from top position—the fact that the "possible" 73,000 tires available for rationing will scarcely meet the requirements of classes 1 and 2A made their prospect of receiving replacements "extremely doubtful", NPN was informed.

ODT Takes Gloomy View

Despite these extraordinary moves, the alarming possibility of a "home front calamity" was forecast by ODT unless early and effective means of alleviating the heavy tire shortage are found.

Reporting on the results of a nationwide emergency survey, ODT said that a "comparatively large number" of essential vehicles, including some 200 over-the-road petroleum transports, are already idle for lack of tires and that "the prospect of getting these trucks into operating condition again is at this time exceedingly gloomy."

That even top-ranking petroleum operations will be extremely fortunate if they succeed in getting replacement tires was indicated by the further ODT comment that "possibly no more than fire-fighting, sanitation, mail and similar municipal requirements, and some city, suburban and intercity bus lines" can be taken care of until such time as the supply situation improves.

Pointing up this prospect as more real than imagined is the fact that on the basis of their "normal" war-time operations, the nation's 12,000 over-the-road petroleum transports alone require a basic minimum of 20,000 tires per month, or nearly two-sevenths of the maximum of 73,000 available for rationing among all classes of consumers.

"I would be derelict in my duty," commented ODT Director Johnson, "if I did not point out that if essential rubber-borne transportation continues to leave the highways, the effect on our war effort will be of significant proportions. We know the military requires large quantities of the same kind and size of tires needed for essential highway transportation. We would not want to deprive the army of a single tire required for present use or for use in the immediate future. However, unless a basic minimum quantity of tires is available for highway use, many war workers will be unable to get to their jobs, and war plants will be unable to make and deliver the vital war materials the armed forces so urgently need."

'Hopes' for Better Days

Although emphasizing that it was only a hope, the ODT director said that he was continuing discussions with WPB in an effort to obtain allocations for fourth quarter needs that would be "large enough to provide for essential requirements and to restore to the highways those vehicles now out of operation."

In the meantime, he urged all operators of rubber-tired vehicles to continue and even increase their efforts at tire conservation.

At the base of the heavy tire crisis was a shortage of manpower. It came to a head, oddly enough, in a week which saw Rubber Director Bradley Dewey declaring proudly that this country was no longer dependent on foreign sources for its rubber supply; that the rubber problem had been licked and

(*Continued on p. 5*)

Subsidy on Stripper Well Production in Effect But Provisions for Payment Are Delayed

WASHINGTON — The administration's substitute for a general crude price increase—a subsidy on production from stripper wells—went into effect August 1—despite the fact that regulations under which payments will be made have not yet been issued.

Purchasers had the assurance of Defense Supplies Corp., however, that they could start paying the higher prices authorized by amendment 2 to revised MPR NO. 436 confident in the knowledge that they will be reimbursed by DSC for all extra costs incurred. This is because the regulations, when issued, will apply to all sales made on and after August 1.

The expectation at DSC, after a two-day session with PAW, OPA, and industry representatives, was that the operating rules for the subsidy program will be issued in final form "within a few days."

Industry men participating in the meeting described the regulations in their present tentative form as "not too complicated," especially from the producers' viewpoint, but said that purchasers might find them somewhat difficult.

The purpose of the DSC-sponsored conference was to discuss provisions of the proposed regulations and the forms for filing claims for reimbursement.

Applicants Fall Into Three Classes

According to a DSC announcement, applicants for the subsidy fall into three classes:

1. The first purchaser of the crude oil produced in an eligible pool;

2. Producers of oil from eligible pools who refine or otherwise use the crude without selling it;

3. Exceptional cases where for convenience of administration it is deemed advisable by Defense Supplies Corporation to name as an eligible applicant a person other than the first purchaser or producer.

Claims are to be filed monthly and will require a separate listing of all purchases (or production, as the case may be) from a particular pool. Claims for any given month must be filed before the end of the second succeeding calendar month, DSC said.

Attending the DSC meeting were the

following from government and industry:

George H. Hill, Jr. and W. E. Unzicker, executive vice president and treasurer, respectively, of DSC., J. Howard Marshall, Wallace Avery and Bruce Clardy of PAW; W. Page Keeton, Robert Eakens and John F. McCormack of OPA; Russell B. Brown of Independent Petroleum Assn.; W. C. Wenzel of Pennsylvania Grade Crude Oil Assn.; J. L. Schumaker of Stanolind Pipe Line Co.; T. E. Smiley of Phillips Petroleum Co.; F. S. Howard of Humble Oil and Refining Co.; J. C. Brooks of The Texas Co.; T. A. Van Griethuysen of Continental Oil Co.; W. E. Emery of the Carter Oil Co.; J. P. Moroney of Sinclair Prairie Oil Marketing Co.; P. H. Curry of South Penn Oil Co.; I. J. Hancock of Union Oil Co. of California; Richard Fenton of California Stripper Well Association; and R. P. Jackson, Oil Conservation Board of Montana.

Irksome Subsidy Problems

Among a few irksome problems connected with the subsidy program which stood out at the meeting and were discussed fully, it is understood, were the questions of "the first purchaser", production information requested of purchasers on the tentative form laid before the conferees, and at which point the transfer of crude from producer to purchaser should take place.

On the first question, it is said to have been fairly well decided that the definition should be broadened to cover as far as possible all special cases. Accordingly final regulations may state that an applicant for the subsidy may be considered a first purchaser if he takes title to the crude at the exit side of the lease tank (for instance, a pipeline company which does the bookkeeping for the company to which it delivers the crude) or, as an option, the person or company, who mails out the checks to ownership interests.

Eliminate Complications

On the second angle, that of a too complicated application form for purchasers, it is understood that several questions dealing with pool and well data will be eliminated from the final form. Consensus of those present, it was said, was that such information would not be available to many purchasers and should not be required. This will probably be done, resulting in definite cutting of red tape for purchasers.

Also discussed was the peculiar situation of a stripper producer who has been selling below ceiling to purchasers. It was thought by some that this might present complications and the opinion was expressed by some government officials, it is understood, that it should be stated explicitly in the DSC regulations that purchasers buying crude from eligible stripper pools must pay the full maximum price, plus the allowed subsidy.

Stripper Subsidy Not the Answer, Says Zook

As IPAA Pledges Right for Crude Increase

FORT WORTH—American independent oil men will renew their fight for a general price increase before Congress, rather than be satisfied with the stripper well subsidy, President Ralph Zook, of the Independent Petroleum Association of America, has announced.

The decision came following a two-day session of the Association's state vice-presidents and its executive committee.

"The main concern of the oil industry right now is to provide the oil necessary to win the war," Mr. Zook stated.

"The subsidy payments for wells of small production will help many operators of marginal wells but they will not answer the problem of finding more oil. The answer is an overall price increase. The independents' fight for this increase has been just, and this association is determined to fight with more vigor than ever before for this just cause."

The Fort Worth session, attended by representatives from 14 states, "was one of the most constructive ever to be held in the history of our association," he added.

At the request of ODT, the directors agreed to cancel plans for the Association's annual convention scheduled in Dallas Oct. 23, 24 and 25. Instead of this 15th anniversary meeting, the group's directors will hold a session there Oct. 9, 10 and 11.

Besides declaring no quarter in the struggle for a higher price for oil, the Association renewed its contention that the importation of foreign oil should be closely controlled. The depletion allowance was another subject that occupied considerable attention, and association heads said special emphasis should be placed on its importance in making ample oil available.

"This is the first time in several recent years that we have not had to present the case (of depletion allowance) to Congress," the IPAA chief stated, "and even this year there are hints that it might come up again."

Mr. Zook was authorized to appoint a committee to study the feasibility of requesting a permanent differential for wells of small or marginal production.

The association also will put on a drive for new members, with the campaign getting under way within the next few weeks in Kansas. Mr. Zook said that "every independent operator in this nation should belong to this association."

Application of the government subsidy program to stripper wells was explained to the directors and vice-presidents by Robert Eaken, head of the research section of the petroleum branch of OPA.

A.P.I. Postpones Meeting, Obeying ODT Request

NPN News Bureau

NEW YORK—On the recommendation of American Petroleum Institute's president, William R. Boyd, Jr., the 25th annual meeting scheduled for Chicago, Nov. 13 to 16 has been deferred indefinitely, the organization announced on July 27.

This action was taken at the urgent request of Director J. M. Johnson of the Office of Defense Transportation that all conventions planned during the remaining months of 1944 be cancelled to save wartime transportation. Mr. Johnson asked that this be done, even at the sacrifice of organization needs.

"The time for holding the institute's 25th meeting will be decided later with appropriate recognition of then existing wartime conditions and necessities", Mr. Boyd said.

Stripper Subsidy Near In California Fields

Application of the subsidy plan in stripper oil fields of California at an early date was seen today by the California Stripper Well Assn. In an announcement to its members the stripper-well trade-group executive vice-president, Richard Fenton, stated: "As a result of conferences between OPA officials and the association there is every indication that the subsidy plan will, as a result of our petition, be applied in California within a few days. If this occurs after Aug. 1, the payments doubtless will be made retroactive to that date." (*See NPN, July 26, p. 42.*)

Two more "stripper pools" were added by the stripper well association to the year 1943 list under current negotiation between the federal price agency and the oil trade group. These pools were Coalinga West (Main), and Whittier (Rideout-Heights Area) each of which had an average per well daily production of less than nine barrels of oil during the year 1943 and, therefore, come within the scope of the plan. The Los Angeles Basin oil field of Buena Park was removed from the list submitted to OPA for consideration on request of the stripper group which stated the field had been termed a "stripper" in error.

Start of an industry effort to obtain a stripper-well subsidy for fields coming within special provisions of the premium price directive of the Office of Economic Stabilization was also indicated in the association's statement which said that the state-wide stripper-well operator's organization is "now collecting data on several pools in California with an average per well production of more than 9 barrels daily for the purpose of negotiating with OPA for special consideration under the subsidy plan."

Truck Tire Crisis

(*Continued from p. 3*)

there was no longer any need for an Office of Rubber Director.

Not only have we developed the supply, but we also have largely finished the expansion of our tire-making plants, Mr. Dewey said. The only trouble now, he added, is that we have yet to find the manpower with which to fill them. That, he emphasized, is the unsolved problem.

"Until these new workers can be found," said Mr. Dewey, "the present shortage of heavy duty large size truck and bus tires will continue to be so critical as to endanger essential over-the-road civilian transportation and the efficiency of some of the military effort. . . . Less than 6,000 additional workers —about half the number to be strong, husky men—stand between the present shortage of tires and an ability to meet estimated requirements."

Procedure Set for Panels

Emergency truck tire rationing panels being set up by OPA are to be guided in passing on applications and issuing certificates by the WPB-announced priority and preference list. Under the temporary plan, truck and bus operators will continue to apply for tires to their local boards. However, instead of the board passing finally on the applicant's need, the application will be routed to the special panel.

Panels apparently will have some leeway in their use of the priority and preference list, judging by the following WPB comment at the time of its issuance:

"Preference based on essentiality is a determination which may be conditioned by: Conservation practices, urgency of the need for a tire, opportunity for diversion to other carriers and the availability and feasibility of using lower grade rubber or recapping. Accordingly, an applicant may not receive the protection and preference accorded by an assigned rating if:

"1. Diversion to other carriers is feasible.

"2. The character of operations, type of equipment, and conditions of tires will permit recapping or use of lower grade tires.

"3. There is another applicant within the same priority class who has a greater degree of urgency.

'Hunting Licenses' Folded Up

OPA's cancellation of certificates dated July 15 or earlier was not such a blow as it might seem, for such certificates have been of little or no value except as "hunting licenses" for a long time past.

According to OPA Chief Bowles, some 100,000 such certificates were made invalid by the OPA action, whether they were in the hands of consumers, dealers or manufacturers. The fact that so many were outstanding, he said, is due to the fact that for several months manufacturers have not been able to ship enough tires to dealers to cover rationing quotas certified to OPA by the Office of Rubber Director. For months of April, May, June and July shipments by manufacturers totaled 103,360 less than OPA quota of 504,500 tires.

Ration certificates issued by local boards on and after July 16 for tires of size 8.25 and larger continue valid. The reason for this, OPA explained, is that by that date most of the truck tire quota remaining in the field was exhausted, and local boards were issuing certificates only to the most essential applicants.

All truck and bus operators holding certificates dated July 15 or earlier must reapply to their local boards for tires on the same basis as an applicant who has not previously been granted a certificate.

Illinoisans Ask Tires, Warn of 'Extinctions'

NPN News Bureau

CHICAGO—Heated demands for relief in the tire shortage which is threatening a breakdown of the transportation industry are coming from Illinois truck operators in protest to the 62,000 to possible 75,000 slash in August truck tire quotas. The Illinois Motor Truck Operators Assn. which number petroleum transporters among its 325 member companies, has presented Sen. C. Wayland Brooks (R. Ill.) with a formal petition demanding congressional investigation of the present acute tire shortage with the summing up: "The motor transportation crisis is national, and extinction is not a matter of months but of weeks for most operators."

The association echoed the sentiments of another Illinois truck operators' association, Central Motor Freight Assn., which told ODT, OPA, ICC and Army Transport Command officials at a joint meeting July 24 that unless emergency measures were taken at Washington to relieve present acute truck tire situation, an approximate 10% of the transport trucks in the area would be out of use for lack of tires within the next few weeks.

Members of the Central Motor Freight Association laid the blame for the present situation on wasteful and inefficient use of current truck tire stocks by Navy, WPB, ODT and OPA.

Harry Chaddick, president of American Transportation Co., charged WPB with holding 50,000 heavy-duty truck tires for use on Army trucks which Studebaker Co. is producing, asserting that it will take a long time for Studebaker to make enough trucks for the tires. Citing another example of inefficient use of tires, Mr. Chaddick told of 100 trucks the Navy has in storage in Chicago which have been standing on an open prairie for about a year until the tires have so deteriorated that a hole can be poked in them with a lead pencil.

Lay-Up Figures Rising

The survey conducted and reported by the association lists 64 carriers reporting on a total of 10,852 pieces of equipment owned and 605 pieces of equipment currently tied up for want of tires. Unless the situation is alleviated, an additional lay-up of 999 pieces is anticipated within the next two weeks. Of the total 10,852 pieces of equipment, 8848 trucks are without spares; 3922 truck days have

(*Continued on p. 7*)

New Plane Servicing Trailer Developed by U. S. A. A. F.

Refueling of aircraft at fighter plane bases has been speeded up with this new U. S. 220-gal. servicing trailer which can be towed by a jeep in tandem trains of from one to five units. The new trailer, developed by the U. S. air forces, can be towed at 20 miles an hour

Group Three Pricing Practices Will Form Basis For 'Gas' and Kerosine in 11 Midwest States

WASHINGTON — New spelled-out maximum delivered-at-destination ceilings on gasoline and kerosine delivered in tank cars and transport trucks throughout 11 midwestern states, involving also creation of three classes of purchasers, and employing Group 3 prices as a basis, are in final form at OPA and are expected to be issued within the next week or so.

Along with its "legalization" of Group 3 pricing practices in the Midwest as to future transactions, OPA oil price officials are expected to meet with enforcement chiefs of the price agency within the next few days to discuss what should be done regarding possible past violations of the oil price regulations by companies which have been selling on a Group 3 basis to customers to whom they did not so sell during the October 1941 base period.

OPA's new rule on delivered-at-destination ceilings in the Midwest is a result of meetings recently held with industry representatives and is understood to carry the endorsement of those in industry with whom OPA has talked over its latest proposal.

Embodies Four Points

Briefly, the new rule embodies the following points:

1. On gasoline sales to tankwagon resellers who were contract buyers during the base period, the supplier's maximum price would be that determined under Section 5.2 of MPR 88 subject to adjustment at subnormal points. (Section 5.2 provides that the maximum price shall be determined by the last sale during the 60-day period preceding Oct. 15, 1941). Thus, in cases involving contracts there will be virtually no change over present pricing rules.

2. The maximum price of a supplier to a tankwagon reseller with whom the supplier had no contract would be: On regular grade gasoline—6.00 cts. per gal. (Oklahoma base price plus the Oct. 1, 1941, rail-rate to destination or the tankwagon maximum price less 2.00 cts. per gal., whichever price was lower; on premium gasoline—6.75 cts. per gal. plus Oct. 1, 1941, railrate, or the tankwagon maximum price less 2.25 cts. per gal., whichever was lower; on third grade gasoline of 60-62 octane—5.625 cts. per gal. plus Oct. 1, 1941, railrate or the tankwagon maximum price for 72-74 octane gasoline less .25 cts. per gal., whichever is lower; and on third grade of 60-62 octane—5.25 cts. per gal. plus Oct. 1, 1941, railrate, or the tankwagon maximum price for 72-74 octane less .25 cts. per gal., whichever is lower.

Only exception under point two above, on the various products listed would be in Indiana and the Chicago Metropolitan Area where, in each case, the base price would be reduced by 0.5 cts. per gal.

3. Maximum prices of a supplier to consumers buying by tank car or transport truck would be the following base prices plus Oct. 1, 1941, railrate (except in Indiana and Chicago area, in which two cases the base price would be reduced by 0.5 cts. per gal. in each case): Premium, 6.75 cts. per gal.; regular, 6.00 cts. per gal.; third grade of 60-62 octane, 5.25 cts. per gal.; and third grade of 63-66 octane, 5.625 cts. per gal. In the St Louis area, a specific price of 7.51 cts. per gal. would be spelled out on sales of regular to consumers buying in tank car or transport.

4. On kerosine, two categories would be set up. They are 41-43 A.P.I. gravity waterwhite kerosine, and 42-44 A.P.I. gravity waterwhite kerosine. On the first, the price to all buyers, when product is delivered by tank car or transport, would be 4.375 cts. per gal. plus Oct. 1, 1941, railrate, except in Indiana where price would be 3.875 cts. per gal. plus Oct. 1, 1941, railrate. On 42-44 gravity waterwhite, maximum price of supplier would be 4.50 cts. per gal. plus Oct. 1, 1941, railrate, except in Indiana where price would be 4.00 cts. per gal. plus base period railrate.

Midwestern area covered includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.

NPN Summary of the Late News

Crude Stocks Reduction Forecast for August

WASHINGTON—On the basis of present production rates, a substantial reduction in crude stocks will be necessary during August, the Bureau of Mines reports, to meet an estimated demand for domestic crude of 4,716,100 b/d above the August, 1943, actual demand.

During five weeks' period from May 28 to July 1, stocks of domestic crude declined 161,000 b/d, indicating a daily demand of 4,718,000 b/d on the basis of a daily average crude production during that period of about 4,557,000.

5,000 Automobiles Is August OPA Quota

WASHINGTON—Quota of new automobiles available for rationing has been further drastically reduced, it was revealed when OPA released its quota figures for August.

New quota will be 5,000—50% of the May quota and 2,000 cars under July quota of 7,000. In addition to quota of 5,000 cars, a total of 1,000 has been set aside as reserves, of which half are for regional reserves, available only to meet emergency applications.

2,000 Asphalt Cars Diverted to Crude Service

WASHINGTON—At request of PAW, ODT has ordered 2,000 tank cars diverted from asphalt service to hauling crude from Gulf Coast to refineries in Dists. 1 and 2.

Action was taken in conjunction with Public Roads Administration, which is asking all state road commissions to determine which roads are in most need of repairs and those on which work can be delayed, due to need for using cars now hauling asphalt in PAW certified essential services. Asphalt shippers are to be notified where paving asphalt is most needed, according to judgment of road commissions, so that shipments may be concentrated and tank car requirements reduced to minimum.

PAW Relaxes on Materials for Refining and Transportation

WASHINGTON—PAW today announced that automatic authorizations would be granted for use of materials in construction, installation or extension of operations incident to refining or transportation of petroleum up to $10,000. Action was taken by amendment to PAW Order 15, effective July 27.

Previously it was necessary to apply for authorization if material cost was in excess of $5,000.

OPA Sets Up Ration Currency Control Organization

WASHINGTON—OPA has announced the organization of a division of ration currency control which will coordinate functions and activities related to production and use of ration stamps and coupon and other forms of ration currency from time of design and issuance through final disposition.

Head of new division is Louis J. Kroeger, of Sacramento, Calif.

Roddewig Is New ODT General Counsel

WASHINGTON—New ODT general counsel is Clair M. Roddewig of Minneapolis, according to announcement by ODT Director J. Monroe Johnson. He succeeds Jack Garrett Scott, who resigned April 6.

A native of Nebraska, Mr. Roddewig is a former Attorney General of South Dakota. He joined the legal staff of Interstate Commerce Commission in Minneapolis in 1939 as district field attorney. He has been with ODT since 1942, first as attorney in charge of local transport matters and later as assistant general counsel in charge of matters pertaining to railroads, buses, water carriers, taxicabs, storage and street cars.

ILLINOIS WANTS TIRES

(*Continued from p. 5*)

been lost for want of tires within the past 30 days and 297 pieces of equipment have been out of service for more than 30 days. A total of 3,895 certificates is being held, for which holders cannot get tires.

Rogers Cartage Co., Chicago, a petroleum transporter included in the survey, owns 246 pieces of equipment and holds 146 certificates for which tires cannot be secured. At present, 19 units belonging to the company are laid up for lack of tires and 10 more are expected to be out of service within the next 30 days for want of tires. The company has lost 45 truck days within the past 30 days because of the tire situation.

Truck operators in attendance at the meeting with the federal agency representatives suggested several ways in which war agencies might clear up present critical situation which federal agency men promised to "refer to Washington".

Operators asked for national revision of OPA truck tire certificate issuance procedure to insure certificate holders from one area against raids on tire stocks on hand by holders in adjoining areas since, they asserted, present procedure enables out-of-date certificate holders to deplete local dealer tire stocks at expense of Chicago operators who have applications pending. Operators further asked that issuance of certificates for new tires be restricted specifically to those truck operators who show definite proof of being engaged in essential movement of war goods and also that all federal agencies appeal to WPB, the Army and to Bradley Dewey, rubber director, for an increase in truck tire quotas for the Chicago area, which is said to be entirely too low in relation to quotas set elsewhere and in consideration of importance of Chicago as a war production transport area.

"How to Prevent Roadside Flat Tires" Pamphlet Issued by ODT As Aid in Maintaining Pressures

NPN News Bureau

CHICAGO—ODT here has called attention to a pamphlet just issued by the maintenance section of their highway transport department giving a new simple method for detecting slow leaks in tires of automotive vehicles to minimize the possibility of roadside flats.

Suggestion is that service stations and garages maintain records of tire pressures for customers each time the customers' tires are checked in order to discover slow leaks in excess of the normal amount. The ODT pamphlet contains samples of forms which may be reproduced by gas stations and garages carrying their own imprinted names. The pamphlet is titled "How to Prevent Roadside Flat Tires," and is obtainable from Maintenance Section, Highway Transport Dept., ODT, Washington 25, D. C. There is no charge for single copies, and quantity purchases may be made from Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C.

The booklet is based upon surveys and careful tests, ODT said, which reveal that slow leaks cause needless destruction and premature wear of millions of tires and tubes. In explanation of the tests, ODT said there is a constant small loss of air from tubes due to the natural characteristics of rubber. However, in experimental tests nails were driven into passenger tires and tubes of standard design, and it was found that abnormal air losses seldom developed within the first day. Typical experiment cited by ODT was the driving of 4-penny nails into each of the tires and tubes of the same vehicle.

Following operation of the vehicle in the customary manner, the record showed that tire No. 1 ran over 2300 miles before going suddenly flat. Tire No. 2 ran over 3900 miles, tire No. 3 ran 5100 miles while tire No. 4 had not gone flat after 8480 miles.

Simple test suggestion offered service stations by ODT is: (1) make certain valve caps have been screwed on finger-tight and that each cap has a rubber washer; (2) before adding air, test and record the pressure in each tire; (3) check the variations in tire pressures—marked difference in pressure indicates slow leaks and the tires showing abnormal losses should be removed for immediate inspection and repair.

PASSENGER CARS

Comparative Air Loss System

TIRE PRESSURE RECORD

DATE CHECKED	LEFT REAR	RIGHT REAR	RIGHT FRONT	LEFT FRONT	SPARE
3/28/44	30	28	(24)	27	29

TRUCK AND BUS

Comparative Air Loss System

TIRE PRESSURE RECORD

DATE CHECKED	FRONT		1st REAR AXLE				2nd REAR AXLE				SPARE
			RIGHT REAR		LEFT REAR		RIGHT REAR		LEFT REAR		
	RIGHT FRONT	LEFT FRONT	OUT SIDE	IN SIDE	OUT SIDE	IN SIDE	OUT SIDE	IN SIDE	OUT SIDE	IN SIDE	
3/21/44	68	70	69	66	(61)	67	70	68	66	69	

These report forms may be reproduced by oil companies for their own use. Pamphlet giving complete information may be had from ODT

Gulf Wins Partial Victory In Regional WLB Decision

NPN News Bureau

WASHINGTON—While upholding a finding of violation, the National War Labor Board has reversed determination of the Eighth Regional WLB at Dallas, Texas, that $78,267.98 of unauthorized wage payments made by Gulf Oil Corp. should be disallowed by other government agencies as a cost of the company for income tax purposes or in applying any other law or regulation.

The Board directed the Regional WLB to reconsider the amount to be disallowed as costs under the wage stabilization act "and give additional consideration (A) to the fact that there was here voluntary disclosure and (B) to the fact that the increase was found to be approvable under the wage stabilization rules." The action grew out of Gulf's putting payment of time and a half for overtime into effect without necessary prior approval.

8 Big Tankers Added to Fleet Named for California Hills

Special to NPN

SAN FRANCISCO—Eight leading oil producing areas of California will provide names for eight additional tankers to be built at Marinship, Sausalito shipyards on San Francisco bay, it was announced last week.

These ships, besides those previously announced, boost to 32 the number of ships which will comprise the Hills class of large turbo-electric tankers named for important California petroleum fields.

Scheduled for delivery in May and June, 1945, the ships will be named Santa Fe Hills, Dominguez Hills, Paloma Hills, Fullerton Hills, Belridge Hills, Coyote Hills, Huntington Hills, and Wheeler Hills.

The oil deposits for which they are named are in Los Angeles, Kern, and Orange Counties.

Jersey-Louisiana Merger Is Slated for Year End

NPN News Bureau

NEW YORK—A plan to merge Standard Oil Co. of Louisiana and Standard Oil Co. of New Jersey at end of 1944 was announced this week by Jersey's president, M. J. Rathbone. The Louisiana concern is a wholly-owned subsidiary of Jersey Standard.

Mr. Rathbone said no material change in the organization at Baton Rouge, La., present headquarters of Louisiana company, is planned, and the same local management will continue to handle the company's affairs in the Louisiana territory.

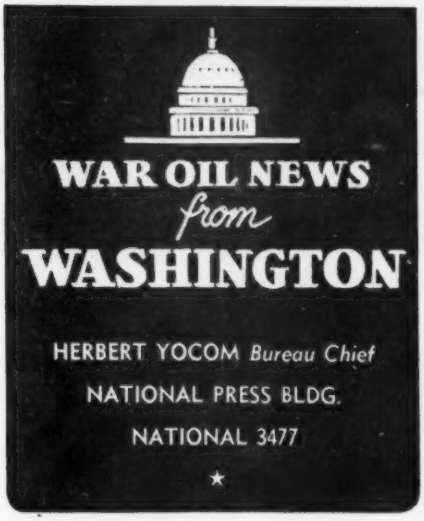
Rathbone will head the consolidation. M. W. Boyer, executive vice president of the Louisiana company, will become a vice president of the consolidated company.

Camera Snaps British-American Oil Conferees

Decisions of high importance to the oil industry are soon to be made in Washington, and shown in the accompanying photographs are some of the men who will make them. High American and British officials engaged in the international oil talks are shown in the above photograph at the conference table. Immediately below is the British lineup with Lord Beaverbrook in the center. On his right (right to left) he is flanked by Richard Law, Sir William Brown and Victor Butler; on his left (left to right) by the Right Honorable Ben Smith, Ralph Assheton and Geoffrey Lloyd.

The third picture from the top, the American conference group, left to right, Leo Crowley, Ralph K. Davies, Secretary Ickes, Secretary Hull; Charles Rayner, Harry Hawkins, Secretary Forrestal, and Undersecretary Patterson. At the right, Lord Beaverbrook, right, shakes hands with Mr. Hull shortly before the conference got underway. With them is Richard Law, British Minister of State (See article on Page 9)

What After War for Big Inch and 100-Octane?
Congress Likely to Answer This $64 Query



NPN News Bureau

WASHINGTON—To government officials studying the war-end disposal of government-owned facilities, the most perplexing problem of all, they say, is what to do about 100-octane plants and the Big Inch and Little Big Inch pipelines.

They describe this problem, frankly, as the $64 question. It is one they haven't gone into very deeply as yet, however, so their thinking is far from crystallized, but here are some of the questions that are already running through the minds of these officials with respect to:

100-OCTANE PLANTS—Will it be possible to dispose of some government-owned facilities to other than the owners of the refineries to which these facilities are now attached? The thought here is that it may be feasible, in at least a few cases, to sever the government-owned plant from its present refinery connection and make a hook-up with the nearby plant of a small refiner, thereby improving his chances of competing successfully with his bigger neighbor for post-war markets.

BIG AND LITTLE BIG INCH — Should these grant lines be retained by government, or should they be sold, and to whom? For what should they be used: petroleum or natural gas? What strings, if any, should be attached by the government if the decision is to sell?

Admitting openly that the answers to these puzzlers won't come easily, officials with whom NPN has talked seem inclined to toss the whole matter to Congress for decision.

That Congress stands ready even now to make that determination, and with particular respect to these very same oil facilities, was evidenced this week in the recommendation of the Senate Small Business subcommittee on surplus war property disposal that no plant for manufacture of high-octane gasoline or any pipeline, in either of which government has invested $5,000,000 or more, be disposed of until Congress has had an opportunity to consider alternative disposal methods.

Other Resources Affected

Plants for the production of aircraft, aircraft parts, synthetic rubber, aluminum, magnesium or steel; government-owned ships (including tankers, of which the committee said there might be a $1,970,000,000 war-end surplus), and shipyards were included in the same category by the Senate group.

Views of the committee, headed by Sen. Stewart (Tenn.) and including Sens. Murray (Mont.) and Taft (Ohio), were incorporated in the draft of a proposed bill which it said "presents a specific approach to some of the many troublesome problems in surplus disposal." The group cautioned, however, that although the measure "instruments certain accepted aims," it was being offered "only as a convenient means of obtaining congressional and wide public comment in terms of concrete and specific legislative provisions, and is without subcommittee commitment." In other words, the members reserve the right to change their minds after going into the problem more fully upon the reconvening of Congress.

The single exception to the proposed withholding of high-octane plants and pipe lines from sale, according to the legislators' bill, would be in cases where disposition "is required by a valid contract provision in effect upon enactment of this Act." Pending final determination of policy by Congress, however, facilities on which the disposal ban would be imposed would be leased by the Surplus War Property Administrator for not to exceed a 2-year term.

Discussing the idea of a ban on disposal, the Stewart committee pointed out, in what was labeled as a "preliminary report," that virtually all government-owned plants (100-octane included) carry an outstanding option to purchase in favor of the contractor who operates the plant. There are "hundreds" of variations in these options, however, it said, quoting the attorney general as having testified that "some" of them "may be void as against public policy."

Without stating which ones it had in mind, the committee continued that many options now outstanding "are held by corporations which dominate their industries by virtue of their vast holdings."

Opposes 'Aggrandizement'

Accordingly, it said: "The Congress should be slow to allow the further aggrandizement of such corporations by permitting the honoring of options which are of questionable legality or whose price and other terms are not strictly complied with. In many cases, regardless of option, a contractor who is now operating a government plant will be the likeliest purchaser, but there does not seem to be any reason for fortifying his position as against other prospective purchasers through the honoring of dubious option claims."

While admitting that many plants, including specifically high-octane and synthetic rubber plants, can be disposed of economically "only to companies which have access to the patented technological processes of the industry," the committee suggested that if there were to be any widening of the base of ownership in such industries, "it would be necessary to provide for the licensing of such pat-

British-American Oil Pact Takes Final Shape

NPN News Bureau

WASHINGTON—Despite official assurances that all was going well, differences over what were described as proposed minor amendments appeared this week to be slowing up negotiations for a British-American oil pact.

Details of the agreement were still in the hands of a working subcommittee representing both countries at NPN press time and the prospect was that one or two more meetings would have to be held before the text is in shape for submission to the top policy committee for consideration and ratification. The expectation, or hope, in official quarters was that final action might be had before the week was out.

Nature of the points still unsettled could not be ascertained. Admittedly, however, both nations came to the conference with the intention of suggesting changes in the "memorandum of understanding" reached last May.

According to British sources, speaking in advance of the current sessions, the modifications to be proposed by that country's delegation were to be only "minor" and would represent "no departure" from the basic principles set forth in the May memorandum. U. S. participants likewise minimized the importance of amendments they would advocate.

Some observers believed it significant that the top policy-making conferees have met only twice thus far—once for a half-hour on Tuesday, July 25, for the purpose of organizing and again on Thursday, July 27. In the meantime, the working subcommittee has held at least four sessions as a group, and there have been any number of separate British and American meetings, apparently for the purpose of considering changes put forward by the opposite group.

ents to prospective purchasers of government plants. The license could be limited to run with the plant. Any specific proposal in this field would have to wait upon the completion of studies on the subject in congressional committees and the executive agencies, including, particularly, studies of the disposition of industrial processes and patents developed at Government expense in privately owned plants and those held by the alien property custodian."

Report of the committee, which was issued for the purpose of pointing up the need for protecting small business when the time comes to dispose of an estimated $104,000,000,000 surplus of government property, also discussed the necessity of affording some protection for the government's large investment in a "great variety of intangible property."

These "intangibles", it said, include the industrial techniques, processes and inventions developed in government plants, at government expense or under government sponsorship, or which have been vested by the alien property custodian under the Trading With the Enemy Act.

Pointing out that these, too, will become surplus with the war's end, and should be made available to industry "in such a way as will best promote the public interest," the committee said that new techniques constitute an important property, disposal of which "is a matter of concern, not merely to the individuals and corporations that may obtain them, but to our society as a whole."

'Fateful in Monopoly Hands'

"They are of particular interest to small business," it added. "They might become a fateful instrument in the hands of monopoly. Their distribution may be a determining factor in the character of our future economy."

In the meantime, pending more mature study of the disposal problem by the Stewart and other congressional committee, Jesse Jones' Defense Plant Corp. has already about half completed an industrial survey of all government-owned plants to be used when their disposal and conversion to civilian production is considered.

While the survey has not gone very far into the field of 100-octane plants and pipelines, officials expect it to bear out what was reported at the beginning of this account—that until such time as Congress sets the policy, no one can predict safely just what is to be done with these facilities.

Here, according to Mr. Jones, are some of the things that are included in the DPC survey; detailed engineering reports on plants, details of cost, photographs, maps, plant layouts; information on taxes, utilities, transportation, raw materials, and studies of convertibility to peace-time operations.

Also, Mr. Jones said, DPC is analyzing operating costs of different plants in given fields and of different products which are competitive or potentially so. Where new products or processes have been developed, it is exploring methods of cutting the cost of operation and of improving both products and processes.

Prospective purchasers of plants, said Mr. Jones, "should not expect bargains, but will be assured of fair prices. Bargains would prove unfair to the purchasers' competitors and to the taxpayers of the country. While no set formula can be applied as regards the sale price of the plants, the salient factors entering in such determination are present reproduction cost, the cost of adaptation to civilian production and the cost of special wartime installations having no peacetime value."

"Where private financing is not available," he added, "the Reconstruction Finance Corp. stands ready to supply all necessary and proper financing in the sale of these plants. In appropriate cases, a temporary continuation of a leasing program such as Defense Plant Corp. has used during the war may be useful in putting plants into early production."

OPA Scraps Gravity, Reverts to Flat Price Method for Computing No. 6 Fuel Oil

WASHINGTON — Coincident with elimination of the gravity scale method of residual pricing which has been in effect for more than a year, OPA this week announced a new flat price for No. 6 fuel oil, on a dollars-and-cents basis and irrespective of gravity.

The action, effective August 1, will maintain, as a price for No. 6, the approximate average price which has been paid for heavy residual since the gravity scale went into effect on March 3, 1943, OPA said. The new No. 6 ceiling is the former maximum price for 13-15.9 gravity fuel oil under the now-discarded gravity pricing system.

Dollars-and-cents prices are set in the new amendment (No. 13 to MPR 88), for 23 refinery and tanker terminal areas, the price per bbl. for No. 6 varying from 92 cents to $2.16. OPA presented this example: In the state of Oklahoma, which is in price Area B, and along the Gulf Coast, which is in price Area D, the current ceiling for 13-15.9 gravity fuel oil is 97c per bbl. This now becomes the new ceiling for No. 6 fuel oil in those areas. In price Area M, which comprises all East Coast refineries and tanker terminals from Norfolk, Va., north, the current ceiling is $1.77, which becomes the new No. 6 fuel oil ceiling in that area.

OPA went on to say that in establishing the new flat prices, it has returned to the pricing system for residual which was in effect prior to the adoption, at the request of industry and PAW, of the gravity scale method of pricing. This, it added, "will facilitate production of distillate fuel oils, and simplify marketing procedures by eliminating numerous grades, on a gravity basis, of No. 6."

OPA also pointed out that although the new prices go into effect Aug. 1 at tanker terminals and refineries, sellers at other shipping and delivery points, such as sales from tank wagons and at other reselling points, may continue to use the old ceiling price, a gravity basis, until their inventories as of Aug. 1 are disposed of, but in no case may the old prices be used later than Sept. 1.

Fuel oils with lower viscosities than No. 6, such as No. 5 fuel oil, will carry either the ceiling prices established by other provisions of the MPR 88, or the new No. 6 ceiling, whichever is higher.

The OPA announcement also said:

"When the gravity system of pricing was established on March 3, 1943, there was a critical deficiency of residual fuel oils in almost all parts of the country, due to increased railroad, industrial and Naval activities, as well as reductions in refinery operations resulting from curtailed marine transportation of petroleum products.

"Now, however, the shortage of distillate has become more acute than the shortage of residual fuels, and the current market indicates a diminishing demand for extremely light residual fuels when sold for uses normally requiring No. 6 fuel oil.

"In addition, it is the judgment both of OPA and of the PAW that the continuance of the gravity scale is not a prerequisite to the production of the necessary amounts of oil.

"However, under the new action, con-

Interest Keen in Scientific Hiring

Many Companies Want Reprints of NPN Story

In response to many requests, we have made arrangements to supply reprints of the story in NPN of July 19, describing the Sohio personnel program.

In addition to outlining the background of scientific experience and thinking from which the Sohio program was developed, the NPN article carried reproductions of some of the forms being used for interviewing and classifying prospective employees.

Reprints—in the form of four-page folders—may be ordered from NPN at the following prices:

50 copies	$20
100 copies	32
250 copies	60

sideration was given to the fact that the volume of production of residual fuel oil must continue at a higher level than obtained during the 60-day period preceding Oct. 15, 1941, the base pricing period, and for that reason a higher price is established for No. 6 commercial standard specifications than the price in effect before the gravity scale was adopted.

"Residual Fuel Oil Industry Advisory Committees representing the various PAW districts (except District 5) were appointed by OPA to consider the question of whether or not the gravity scale should be discontinued. Each of the four committees separately considered the question and recommended discontinuance of the gravity scale."

Germany's Petroleum and Synthetic Production Cut 50 Per Cent by Allied Bombing Attacks

WASHINGTON — Germany is now facing its most critical oil shortage, Leo T. Crowley, Foreign Economic Administrator declared this week in making public an analysis of Germany's oil position prepared by his agency.

Whereas German production of natural and synthetic petroleum products was enough as late as April not only for all essential needs but also to increase German reserve stocks substantially, the administrator said, in less than four months allied bombing has reduced this production to a point where it falls far short of meeting minimum essential consumption needs even after drastic curtailment of important war uses.

"Beginning in April, increasing in May, and reaching an even higher scale in June and July, a systematic campaign of destruction of the crude oil refineries, hydro-carbon synthesis plants, and the great hydrogenation plants in Axis Europe has been undertaken," he continued.

"Although Germany has countered with restrictions so drastic that she has even retarded her war industries and war agricultural programs she still must draw heavily upon the limited reserve stocks previously accumulated.

Enemy Production Down 50 Per Cent

"Germany's total production of liquid fuels and lubricants, including such gasoline substitutes as alcohol, is today much less than 50 per cent of what it was in April. Production from her synthetic plants is less than 60 per cent of the April rate while the crude oil refineries have been hit so hard that their production rate is at most only 40 per cent of what it was in April. In other words, Germany can refine only two out of every five tons of her crude petroleum.

"Germany is now facing her most critical oil shortage."

German crude oil refineries as well as synthetic oil plants, some of which cover 4 to 5 square miles and produce many by-products in addition to oil, were greatly expanded whenever possible after the war started and after the Germans realized they would be unable to seize the oil in the Caucasus. Approximately half of Germany's oil production is synthetic.

"Before April of this year, damage caused by Allied bombings had not had a serious effect on Germany's oil supply," Mr. Crowley pointed out. "Repairs to those synthetic plants and crude oil refineries accessible to Allied bombers could be made with relative speed. Moreover, there was available in the western Axis occupied countries considerable excess refining capacity. Crude oil could thus be diverted to undamaged refineries."

Army Fuel Oil Specifications Revised for Diesel Engines

WASHINGTON—Army specifications for fuel oil for high speed automotive type diesel engines have been revised, effective July 8. The new specification (2-102C) published July 28, provides for two grades of fuel in place of the three called for in the former specification 2-102B.

Grade A covers the all-purpose diesel fuel intended for general use where mean atmospheric temperatures are anticipated between 0 F. and extreme heat. Grade C covers the special diesel fuel intended for use where extreme low temperatures are anticipated (extreme cold to 0 F.)

Minimum cetane number of 40 is provided for both grades in the new specifications, as compared with 50, 47 and 45 for the former grades A, B and X respectively. More severe cloud and pour point requirements are specified. Under certain conditions, however, fuels of higher cloud and pour points may be used.

The new specifications issued by the Quartermaster General, Army Service Forces are as follows:

Specification	Grade A all-purpose	Grade C Arctic
Cetane Number, min.	40	40
Distillation Test		
90% point, Deg. F. max.	650	600
End point, Deg. F. min.	700	650
Flash Point, Deg. F. min.	140	110
Pour Point, Deg. F., max.	—10°	—50°
Cloud Point, 0 F. max.	0°	—40°
Kinematic Viscosity centistokes at 100 F.	1.6-4.28	1.5-4.28
Carbon Res. on 10% bottoms, max.	0.15	0.15
Sulfur, % max.	1.00	1.00
Water and Sediment	nil	nil
Corrosion	pass	pass

*Higher pour and cloud point oils can be used under certain conditions.

The fuel covered by the new specification is intended for Army use within the continental U.S. and for other areas under certain conditions as outlined. For combat areas or for special training areas only diesel fuels meeting Navy 7-0-2 specification can be used.

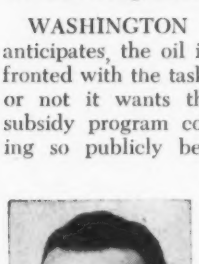
Rolling Out the Barrels for U. S. Forces on Biak

From a U. S. LST American soldiers unload drums of oil and gasoline for U. S. planes and motorized equipment on the Southwestern Pacific island of Biak. A truck is also being backed down to the bow of the LST, a type of vessel that has aided Allied amphibious victories

PIPELINES—*Views of the Industry's Problems*

Washington—*Industry Must Speak if It Wants Stripper Subsidy After Jan. 1*—By Herbert A. Yocom

WASHINGTON — Sooner than it anticipates, the oil industry may be confronted with the task of deciding whether or not it wants the new stripper-well subsidy program continued and of saying so publicly before a congressional committee. Reason for that is some rather involved but pointed language inserted in a couple of acts that went into the statute books within the last two months — Public 383, extending the life of OPA, public 358, appropriating funds for various independent government agencies.



Mr. Yocom

Section 213 of public 358 contains the so-called Russell amendment which requires all agencies created by executive order to request and obtain an appropriation from congress for direct operating expenses or go out of business Jan. 1. There is a provision, furthermore, that prevents the executive branch setting up a new agency to carry on the functions of any agency that may be refused operating funds. By interpretation of the comptroller general, Defense Supplies Corp. is one of the agencies that falls within the scope of section 213, and DSC happens to be the RFC subsidiary handling the stripper program. As for public 383, its section E provides that subsidy payments may be made only by corporations created or organized pursuant to section 5D of the RFC act, and DSC is such a corporation.

All of which makes it fairly obvious that if DSC should happen to be wiped out by congress the stripper-well subsidy program will come to an abrupt end Jan. 1.

From this it would appear that if industry wants the stripper subsidy continued it is going to have to help DSC make out a case for itself when the time comes for congress to pass on a request for operating funds. Contrariwise, if industry wants the subsidy killed then the way is open for that, too, but it will mean the death also of all other DSC programs, including those under which that agency compensates for extra oil transportation costs.

° ° °

We've licked the rubber supply problem and soon we'll have all the plant capacity needed to turn out tires to meet the expanding war demand.

Why, then, the present shortage of heavy duty tires which already has forced some 200 petroleum transports into what may be permanent idleness and threatens, in the words of ODT, a "calamitous breakdown" of all forms of essential civilian truck and bus operations?

For the answer to that one, the nation need look no further, it appears, than our old friend Paul Voorhies McNutt, the handsome, white-haired Hoosier. Why? Because Mr. McNutt happens to head up the war manpower commission and WMC, under his direction, doesn't seem able, for some reason or other, to find the workers to man the plants which now—today, even—could be turning our adequate supply of rubber into desperately-needed tires, and in adequate quantities.

Failure of Mr. McNutt to make good on the job of recruiting tire workers could not have been brought more forcibly to public attention than was done by Bradley Dewey, the rubber director, in the following comment:

"We have synthetic rubbers, tire cords, carbon blacks. By presidential directive, the responsibility for supplying more manpower lies with the war manpower commission. Less than 6000 additional workers—about half the number to be strong, husky men—stand between the present shortage of tires and an ability to meet estimated requirements. Manpower is the unsolved problem."

In other words, the answer to whether the situation is to get better or worse is strictly up to Mr. McNutt, unless the president sees fit to take the responsibility away from him and place it in other, more competent hands, as American Trucking Associations, Inc., seems to be urging.

Atlantic Coast—*Autumn Court Action Involves Names of Big Companies*—By Frank P. S. Glassey

NEW YORK — Names of some of the nation's biggest oil companies will figure this fall in a suit filed in the U. S. District Court at Wilmington, Del., by Sinclair Refining Co. against M. W. Kellogg Co. and Universal Oil Products Co.

Mr. Glassey

Details of the complaint, revealed last week, show that the action is based on an agreement made by the defendants on Aug. 7, 1942, with Shell Development Co., Standard Oil Development Co., Texaco Development Corp. and Standard Oil Co. of Indiana, providing for the grant to Universal Oil Products of licenses for catalytic refining, including the fluid catalytic cracking process.

Sinclair contends that by another agreement dated March 8, 1933, Universal Oil Products released Sinclair from all claims for past infringements of U.O.P. patents, and that by reason of the agreement of August, 1942, U.O.P. obtained transferrable patent rights which it was obligated to license to Sinclair provided Sinclair gave the oil companies a royalty-free, non-exclusive license or immunity for the same process under Sinclair's patent rights.

The bill of complaint charges that in April of this year Kellogg tendered a proposed license agreement to Sinclair, providing for the payment of substantial royalties. Sinclair declined to accept this offer, and in June formally asserted its claim to complete immunity without further consideration regarding the fluid catalytic process. Sinclair now asks a declaratory judgment providing:

1. Sinclair has complete immunity under the patents without further consideration.

2. Sinclair may operate its refinery at Sinclair, Wyo., without interference by the defendants or the other oil companies named because of such asserted patent rights.

3. U.O.P. is obligated by the agreement of March, 1933, to give Sinclair transferrable patent rights which it is allegedly empowered to transfer according to the agreement of August, 1942, and to execute and deliver such rights "without further payment of consideration" by Sinclair.

No answer to the complaint is expected before mid-September, at the earliest, and the case may drag along for many months.

° ° °

Davies Optimistic

Deputy PAW Davies stepped into the somewhat chaotic Dist. 1 gasoline supply picture last week, when he issued a statement asserting that civilian gasoline supplies in the New York area should be sufficient during August to meet the "legitimate rationed demand" despite reduced inventories and occasional spot shortages resulting from "transportation imponderables".

PAW discounted recent local rumors that a gasoline drought was impending, and said that July demands had been met in full, although sporadic shortages may have inconvenienced some.

"Stockpiles of civilian gasoline in the New York Harbor area," Davies said, "have dropped substantially since the

first of the year, as was to be expected. This reduces the amount of product available in the event of a real emergency but does not have an immediate effect upon the ultimate consumer, and meanwhile every effort is being made to restore the inventory to sturdier levels.

"The stockpile is sufficient to supplement the flow of new supply in quantities great enough to meet the August demand in our New York area and support shipping schedules to Hartford, New Haven, Newburgh and Albany as previously."

Although Davies' statement tended to allay some anxiety, many service stations were displaying "NO GAS TODAY" signs last week.

Rationing even spread to the black market. It was reported that some dealers who accept counterfeit coupons had placed their customers on a limit of only three gallons. Black-market prices currently range all the way from 45 cents in Manhattan to 95 cents in the suburbs.

* * *

Standard Stocks Sell Fast

The investing public evidently believes there is a future in the oil industry. That, at least, is the conclusion drawn from the sale of 850,000 shares of Standard Oil stocks within 40 minutes after the close of the New York Exchange last Thursday.

The holdings, which included 200,000 shares of Standard Oil Co. of New Jersey, 500,000 shares of Socony-Vacuum, 100,000 of Standard Oil of California and 50,000 of Standard Oil of Indiana, had been offered by John D. Rockefeller, Jr., through Dillon, Read & Co.

Subscriptions were opened ten minutes after the closing of the Stock Exchange at 3 p.m., and they were halted at 3.50 p.m., after sales had been made throughout the country. Numerous bids were received even before the books were opened.

Distribution was effected through members of the National Association of Securities Dealers and members of the Stock Exchange. Prices of all four stocks advanced on the exchange during the day, when all stock transactions totaled only 693,730 shares, or substantially less than the special offering of the four oil companies.

* * *

Baltimore Plan Sidetracked

Trial of the so-called "Baltimore plan" whereby dealers would be allotted gasoline quotas in an effort to combat the black market now seems most unlikely. PAW Dist. 1 distribution and marketing committee last week once more weighed the proposal and found it wanting. The group turned down the program of the Eastern States Gasoline Dealers Assn. on the ground that it was full of loopholes and might do more harm than good.

John Dressler, who headed the retailers, was extremely disappointed at the action taken in the PAW office here. He had suggested Baltimore and Washington, D. C., as areas where the scheme might be tested.

"I still don't believe the black market will ever be conquered except through some such campaign," Mr. Dressler said.

He added that he had no idea what the retailers' next move will be until the Association's executive committee meets in about two weeks.

It is understood that opposition of jobbers to the proposal helped to bring about its defeat.

Midwest— *Mystery Shrouds OPA's Plan For Rationing Naphtha* —By Earl Lamm

CHICAGO — Mystery seems to have overtaken the plans of OPA to ration naphtha as it was reported at the Dist. 2 D & M committee meeting on July 31 that OPA was now preparing a sales limitation order with teeth in it. PAW has had a limitation order on the books for several months but it has not been getting results because PAW's enforcement guns are tender due to lack of sufficient organization for field checks. OPA's teeth are expected to correct this situation, so it's been stated by some. Others don't agree. There are independents who assert that a limitation order cannot be written that will do the job, and that it will take coupon rationing to straighten it out.

Mr. Lamm

Resolutions were passed at the various state jobber association conventions asking for rationing of naphtha. These ideas were summarized and backed up by a similar resolution by National Council of Independent Petroleum Assns. with membership of 16 states in the Midwest. Dist. 2 D & M committee gave its support and on two occasions asked PAW to turn naphtha over to OPA for rationing. Following the last request, PAW said OK.

Rationing naphtha has its complications, but OPA agreed. Now the move is stymied.

Same thing appears to have happened to repeal of OPA amendment 111, banning use of "R" coupons at service stations. There was great clamor for lifting of that ban and substituting ration check books or some other idea developed by test. The whole industry apparently agreed on that. But like naphtha rationing it was delayed. Stories are being circulated that objections have subsided and that the ban will remain.

Who is responsible for the change of heart? Phil Williams, head of N. C. I. P. A., declares it's not the independents for the independents want naphtha rationing and the check book system for "R" coupons.

Present methods of handling naphtha sales and "R" coupons hurt the independents who are trying to live with governmental restrictions. Many farmers live 40 to 50 miles from their ration boards and it has been proven by experience that they will not drive in to exchange "Rs" for "Es" and, if they abide by the rule, must make purchases from tank wagons, which in the majority, means major oil companies. Not all refineries make naphtha and at least the theory of rationing is to spread distribution and with coupons minimize the black market.

* * *

Oil men coming to Chicago this week are having a difficult time finding a place to put their weary heads. All hotels are overflowing with Elks and Lions. The Elks are having their national convention or war conference of the Grand Lodge, July 29 through Aug. 3. From 18,000 to 20,000 are expected to attend and further their program of assistance to men in military service. Elks operate 119 fraternal centers, or "Elk USOs". About 1000 are expected to attend the Lions International convention with members coming from as far away as Venezuela.

* * *

Reduced rail rates effective July 31 from the Group 3 and Southwest areas to the central and northwest sections of the Midwest on all petroleum products below the grade of kerosine, had it occurred in normal times, would have caused a major revision in trade practices. Under present war conditions, oil company traffic men are about the only ones excited about it.

Net effect of the rate reduction will be to intensify competition between refiners in the Whiting, Wood River and Sugar Creek areas of Indiana and Illinois and refiners in Oklahoma and the Southwest.

Application for the reduction was originally filed in December, 1941, by Midland Wholesale Cooperative at Minneapolis and several state oil jobber associations. Interstate Commerce Commission approved it last February but the effective date was postponed until July 31, in order to hear protests, none of which got anywhere and the reduction sticks.

PAW directive 65 zoning supply and

(*Continued on p.* 14)

Profile in Oil

'Sheriff' Is Still Oil Man, Though Whales Are Retired

Friends in Industry Greet James A. McEwan at Half-Century Milestone

NPN News Bureau

NEW YORK—A half century in the oil industry, which started with dealing in whale oil and now consists of handling high-grade lubes, has left James A. McEwan with the conviction that, despite all the improvements he has witnessed he still hankers for conditions of the early 1900's.

Mr. McEwan on Aug. 1 celebrated his fiftieth anniversary as an employee of Swann-Finch Oil Corp., and was the honor guest at a testimonial dinner given by his friends in the industry. The committee in charge included Clarence M. Davison of Standard Oil Co. of New Jersey, Alfred R. Lange of United Industrial Products, Inc., and Jesse A. Jones of Gulf Oil Corp.

On Aug. 1, 1894, Mr. McEwan came to work for Swann-Finch as an office boy at $5 a week. Today he is with the same concern, selling and buying many kinds of petroleum products. In his own words, he plans to keep on working "until I die." He is in the best of health at 64, and has no thought of retiring.

Reminiscing over his 50 years in the oil business, Mr. McEwan admitted that he has seen much progress but added "I'd sooner have the older days when there wasn't the competition there is now."

Mr. McEwan was born in Brooklyn on Sept. 10, 1879, and has lived in the same neighborhood since. He was educated in Brooklyn public schools and high school before he got a job with Swann-Finch at the age of fourteen. After a half year as office boy he was advanced to the order desk and then made the "grand leap" to full charge of shipping.

Mr. McEwan

In 1897 he was made purchasing agent and also placed in charge of sales. He held that joint position until 1929, when the company was consolidated with Cataract Refining & Manufacturing Co. of Buffalo. Since then he has been engaged in both buying and selling.

"When I joined Swann-Finch," Mr. McEwan said, "we were the country's biggest dealers in whale, sperm, cod and menhaden fish oils. Mr. Swann was in charge of those products, and wasn't even acquainted with mineral lubes."

He is optimistic on the future of the oil industry after the war, and thinks it will continue to forge ahead. The government will relinquish present controls to a large degree once peace is concluded, he believes.

Mr. McEwan has been married since 1908, and has six sons and one daughter. Three of his sons are in the armed services. He and his wife live in a Brooklyn home they bought 32 years ago.

Nowadays Mr. McEwan (also called "the Sheriff" as a nickname tagged to him two decades ago) spends almost all of his time in New York. He formerly did much traveling for his company, but says that is no longer necessary "since now they come East from both West and South."

He is well known as a poker player in his leisure moments, and one of his proudest boasts is that he has held three royal flushes—two in clubs and one in diamonds. On each occasion he drew one card in a jack-pot game with nothing wild.

Pipelines—Midwest

(*Continued from p.* 13)

distribution in Dist. 2, which requires distributors to obtain supplies from the nearest terminal or source and the scarcity of tank cars for hauls from the Southwest into the lower rate area makes the rate reduction a matter of small interest at the moment. The situation offers food for thought in postwar planning, however.

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Rubber Director Dewey's resignation is not understood nor too well taken by a great many. He is the second rubber director to tender his resignation with a press release stating the rubber problem has been solved. But today hundreds of trucks are idle because they have no tires and a greater rubber crisis impends. For Dewey to say he was concerned only with synthetic rubber production and not tire production is begging the question. Chicago Daily News on July 28, pointed out that the time is about ripe for the hush-hush fight between synthetic and natural rubber to come out in the open. Our armed forces are now approaching recovery of the rubber plantations in the East Indies.

° ° °

PAW and Dist. 2 industry men who have acquired fallen arches toting around loads of worry about low refinery runs have perked up. Runs to stills in Dist. 2 reached an all time high for week ending July 22, averaging 1,227,000 b/d. It has been six weeks now since runs dropped below 1,200,000 b/d.

° ° °

Maybe there is no basis in fact for it, but the idea persists among oil men in Chicago that Hitler is dead—was killed in the bomb blast from which Goebbel's publicity says he escaped. Contention is that the Nazi clique—Himmler, Goering, Goebbels, et al—appointed themselves to their present respective jobs, thus assuming authority Hitler never would permit while he lived. The fake Hitler radio voice following the bombing, the oil men believe, was too excited, too frantic for Hitler himself.

I.P.A.A. Directors to Meet In Dallas on Oct. 9

NPN News Bureau

TULSA—A meeting of directors of the Independent Petroleum Assn. of America will be held at Dallas, Tex., Oct. 9, 10, and 11, it was announced after a meeting of the association's executive committee and vice-presidents at Fort Worth, Tex., July 26.

The directors' meeting will take the place of the fifteenth anniversary membership meeting originally scheduled for Dallas two weeks later. This change was in compliance with the request of the Office of Defense Transportation to refrain from holding large conventions.

Study Rusk County Oil Rules

Special to NPN

AUSTIN, Tex.—A special hearing has been set for Aug. 11 by the Texas Railroad Commission to determine if special rules, regulations and orders should be set for Henderson Field in Rusk County. The hearing was requested by Beacon Oil & Refining Co. and American Liberty Oil Co.

Good Neighbor for 60 Years!

"Sapolin" is one of the best-known of all American trade-marks in South America . . . quoted on the commodity exchanges . . . specifically mentioned by name in recent Trade Agreements with several countries. For sixty years Sapolin Paints, Stains and Varnishes have been shipped to every Latin-American country . . . except the Argentine.

That extensive export business was built not only on the quality of the product . . . but by careful attention to the special problems created by shipping and storage conditions. The containers for Sapolin products were selected with the utmost care . . . and Crown is proud that its Doubletite and other types of cans carry the Sapolin trade-mark.

Export business to South America will undoubtedly increase for all forward-looking American firms once peace comes. While the Crown organization is concentrating on essential wartime production today . . . the experience gained serving American exporters will again be at the command of all manufacturers when our victory is won!

★ ★ ★ ★ CROWN CAN ★

CROWN CAN COMPANY • NEW YORK • PHILADELPHIA • Division of Crown Cork and Seal Company, Baltimore, Md.

Letters from NPN Readers

Commends 'A' Card Patriots

FROM: Mr. R. L. Lewis, Pittsburgh, TO: The Editor

Congratulations and thanks for your editorials and efforts in behalf of the patriotic sap of America—the "A" card holder.

The "A" card holder, in his own mind, is a patriot, endeavoring to hasten the end of the present conflict, but he realizes that he is a sap in the eyes of some of his fellow citizens with "B" and "C" cards, who have forgotten all about riding clubs, and who have sufficient gasoline to spare to take vacation trips.

There is only one sure way of administering equal treatment to all car owners and that is to prohibit driving a certain period of time. I have advocated, since the start of rationing, that Sunday driving from 1:00 P.M. to about 4:00 A.M. Monday be prohibited. This period should avoid criticism from the churches. It would save gasoline, now being consumed for pleasure driving, mostly by "B" and "C" holders, and would permit allocating the gasoline so saved to the "A" card holder, who could assist more in solving the acute transportation problem by driving to his place of employment more frequently. I believe that the public would take care of enforcement of a Sunday driving ban. Probably the word "slacker" applied to the driver would go a long way in helping enforcement.

One particular phase of gasoline distribution that is confusing to the general public is why the "A" card holder is held to two gallons per week, while, from all reports in the newspapers, gasoline is available to the extent of 2,500,000 gallons per day for the black market.

A Broom for Bowles

FROM: An Independent Refiner TO: The Editor

I have just read with considerable interest your exchange of letters with Mr. Bowles, which were contained in the June 28 issue of the NATIONAL PETROLEUM NEWS.

Although I am definitely not writing for publication, I do want to take this opportunity of complimenting you upon the very vigorous and courageous way in which you have gone after Mr. Bowles and to assure you that most of us in the oil industry feel pretty much the same way about it. In other words, we want to believe in Mr. Bowles; we are not yet ready to accuse him, personally, of being responsible for a lot of crazy things, but he certainly has a lot of housecleaning that should be done in his organization.

How Monopoly Grows

FROM: D. W. Hovey, Hovey Petroleum Co., Houston, Tex. TO: The Editor

Just a line to congratulate you and endorse your editorial in the June 28th issue of NATIONAL PETROLEUM NEWS, "Independents Won Fight that Permits Free Competition—They Are Entitled to Same Tax Status Enjoyed by Co-ops."

Monopoly can only be built up through special privilege or advantages secured in one way or another, generally through integration, and now if the Co-ops are going to have not only advantage of integration but tax exemption as well, then they have an advantage over the major oil companies that if continued will at least make possible the building up of a gigantic monopoly to the possible elimination of not only present independents but major oil companies as well.

Free enterprise is a vague something which the people seem to want and both of our present major political parties are promising. However, I have yet to hear a clear cut statement from any candidate or political party as to just what they mean by free enterprise—any existing conditions preventing free enterprise—and just what they propose to do to correct such conditions so as to restore competition, guarantee and safeguard free enterprise.

It may be we can have free enterprise under a permitted integration wherein profits from one branch of the oil industry can be used to finance unprofitable operations of some other branch to the end that competition is controlled or eliminated and it may be we can have free enterprise by adding tax exemptions to a favored few. However, if this is possible, then I think it is time for leaders of both present leading political parties to explain to the public—how and why—and if impossible then it is up to these same leaders and Congress to advise just what they propose to do about it and how.

If the Co-ops are to be rewarded for furnishing competition to the major (integrated) oil companies, then all non-integrated oil companies are entitled to such tax exemption and unless special privilege is to be granted to a favored few *only*, then such tax exemption should apply only to non-integrated co-ops or oil companies.

Some people are of the opinion that there are too many in authority today in Washington who are in favor of building up (through granting of special privileges) a government-dominated monopoly in all industries and labor, making necessary (and easier) government operation or control of both industry and labor.

In 1932 Mr. Roosevelt promised elimination of special privileges. Did he really mean elimination of special privilege to some and the granting of new special privilege to others willing to blindly support his policies and accept his dictates?

You are doing a good job. Hope it will result in labor, industry and the public taking united necessary actions.

Hits Rule on Officers

FROM: J. B. Fisher, president, Kendall Refining Co., Bradford, Pa. TO: The Editor

I think you rang the bell with your editorial in the June 7th issue of NATIONAL PETROLEUM NEWS in dealing with the inadequate independent representation on oil industry committees appointed to further the industry's war effort.

I think that one, probably unwritten, but none-the-less hamstringing, requirement is that the appointees to some of these committees be officers of their respective companies. In other words, a fellow may be sales manager and be absolutely qualified to serve on the committee, but, just because he isn't Vice President in Charge of Sales, he isn't given the consideration he should be.

You may, perhaps, remember that, in the paper that I gave last Fall before the National Petroleum Assn. at New York, I quoted the statement appearing in the Standard Oil Company of New Jersey's house organ, *The Lamp*, as follows: "Under the American system, the industry that fails to support its small operators is on its way out."

If this philosophy would spread through the majority of the major companies, our problems of representation and marketing would diminish in magnitude, to say the least, and the major companies would, in the long run, be a lot better off. Certainly their expectancy of life as free enterprises would be lengthened.

Court Paves Way for Dismissal of Suits

Special to NPN

MINNEAPOLIS — Dismissal is in prospect for 16 anti-trust treble damage suits brought by jobbers against major oil companies as a result of the Madison oil trial several years ago. This disclosure was made in an opinion by U. S. District Judge Gunnar H. Nordbye, of Minneapolis, when he handed down his decision on July 25 in a treble damage suit brought by two jobbers against nine major oil companies.

The decision was in favor of the major companies and the court's opinion revealed that a stipulation had been entered into providing that in event of an adverse decision in the case at trial, "dismissals with prejudice will be entered in some 16 companion cases involving the same issues."

The two jobbers were Clark Oil Co. and Plymouth Clark Oil Co., of Manitowoc, Wis., and the nine oil companies, Phillips, Pure, Standard of Indiana, Sinclair, Shell, Socony-Vacuum, Skelly, Continental and Cities Service.

Plaintiffs claimed they had paid a higher price for gasoline as a result of the conspiracy involved in the Madison oil case and Judge Nordbye held that: "It has now been settled in the so-called treble damage oil cases, arising out of the conspiracy referred to, that a jobber of gasoline is not entitled to recover damages merely because there has been an increase in the price of the gasoline bought as the result of the conspiracy, but he must affirmatively establish a pecuniary loss to his business and property by reason of such excessive payments."

Commenting further, after having reviewed decisions rendered in favor of major oil companies in similar cases, Judge Nordbye concluded: "One is impelled to find, therefore, that they have not sustained any injury or damage within the meaning of the anti-trust statutes and, absent injury, there can be no recovery for the wrong."

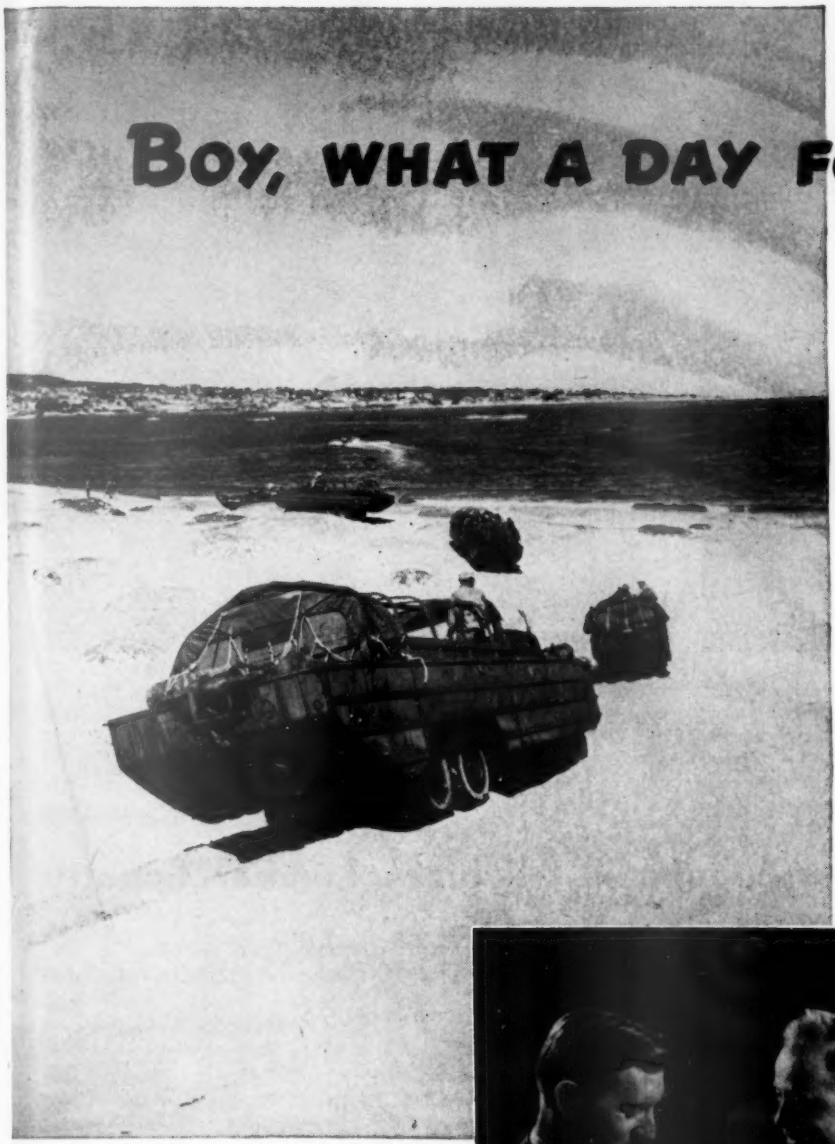
Indiana Independents Meet Oct. 11 and 12

Special to NPN

INDIANAPOLIS—The fall meeting of the Indiana Independent Petroleum Assn. will be held at Severin Hotel here Oct. 11 and 12. Speakers scheduled to date include E. R. Sneed, Socony-Vacuum, St. Louis; C. T. Burg, Iron Fireman Mfg. Co., Cleveland; Bruce K. Brown, assistant deputy PAW, and Jack Major, humorist.

Announcing the meeting, President Phil Williams said association directors, questioned on the subject, feel that the state meeting will not interfere in any way with transportation and that exchange of ideas which take place at meeting is necessary to smoother operations. Four directors will be elected at the fall meeting to succeed Phil T. Williams, C. B. Parrish, J. Ivan Harris, and R. J. Rogers, whose terms will have expired.

BOY, WHAT A DAY FOR "DUCKS"!



AHEAD OF THEM . . .

. . the low, flat, land-mined beaches of Hitler's France. And, as time runs out for the enemy, Paris! Then Berlin, itself!

Yes, when D Day, H Hour arrived . . . the Army's amphibious landing craft, known as "Ducks" by men in combat, were in the forefront of the invasion parade! And they're *still* in there!

In the water, they swim! On land, they roll! Proof, if proof is needed, that American ingenuity is exploiting every means of carrying this war to the enemy!

BEHIND THEM . . .

the fighting Petroleum Industry!

For not only are these amphibious craft powered by petroleum fuels, but the Petroleum Industry also had a hand in their construction.

The Petroleum Industry furnishes cutting oils, quenching oils, lubricants, and rust preventives as well as ingredients for plastics, synthetic rubber, and gun powder . . . all being used in staggering quantities by America's ever-growing war machine.

Truly the Petroleum Industry is behind America's vast war effort. Gulf is indeed proud to be a member of it.

GULF

Ready Today with the Fuels of the Future

William Salo, an "A" card logger at Hancock, Mich., pledges to use only rationed gasoline as he pastes the Victory Emblem on his windshield. The emblems are sponsored by National Petroleum News as a means of honoring the patriotism of the "A" card driver

Miss Ethel Bishop, Hancock, Mich., displays a Victory Emblem honoring "A" card drivers for sacrificing gasoline to the war effort, before sticking it on the windshield of the family car. Emblems are being awarded by the U. P. Diamond Oil Co.

'A' Card Victory Emblems Popular in Michigan Lumber Country

Helps Keep Customer Until Rationing Ends, Hancock Jobber Says; Logging Demands Due to War Boost Petroleum Sales

By Earl Lamm
NPN Staff Writer

HANCOCK, MICH.—Penetrating the north woods of this upper peninsula, "copper country in the land of Hiawatha," the Victory Emblem honoring "A" card drivers as suggested to the oil industry by NPN, is being stuck hard and fast on the windshields of "A" card motorists hereabout who are sacrificing their pleasure gasoline to hammer home the spike of world freedom.

Recipients of the emblem awards are the "A" card customers of U. P. Diamond Oil Co., distributor of Mid-Continent Petroleum Co.'s D-X products in this most northern area of Michigan which hooks out into the glassy blue of Lake Superior like the trunk of a giant tree, bent by a heavy west wind.

No Longer "Forgotten"

"Soon as I saw the Victory Emblems printed on NPN's cover and read the story behind them, I was struck with the idea that they are a good thing," declared Fred Tormala, manager of the U. P. Diamond. "I immediately ordered 500 of them, which I am distributing to "A" card motorists through our service stations. There is practically no black market in gasoline up here," he explained, "and only two gallons a week of rationed gasoline will not go very far, so the people on this peninsula are really doing without. And besides," he continued, "I've got a lot of good 'A' customers who would buy three times as much gasoline if they could. I want to hold them until rationing goes off."

Mr. Tormala is right. In a country that requires a lot of auto travel in the average car which is old, two gallons a week is hardly enough to crank it. Before the coming of the Victory Emblems, "A" card drivers were the "forgotten men"—and women—of this global war. Mr. Tormala and his customers know about the decorations given heroes at the front, and the prized Navy "E" flags that honor production at home, and the U. P. Diamond jobber believes it is high time the efforts and sacrifices of other patriotic people, like "A" card drivers, are recognized.

All motorists by now have been made to realize how important petroleum products are, or how the lack of them affects the daily rutine of their lives. Mr. Tormala, an energetic Finn, also personally knows what war means for he saw front line service with the 107th Engineers, 32nd U. S. Army division in World War I.

OPA district office at Escanaba, Mich., which takes in this area, agrees with the statement that there is no black market of consequence here. What little there is comes from chiseling on "B" and "C" cards and not from counterfeit coupons.

And more than that, "A" card drivers on this trunk of land mostly covered by tall timber and copper mines, know where much of the gasoline they don't get goes. Some goes to workmen at the copper mines, which are operating again under a subsidy pay-off. The mine machinery is steam and electric mostly, which eliminates gasoline and Diesel fuel, but the machinery requires large quantities of industrial lubes. Farming and commercial fishermen use a considerable volume of gasoline, but tank wagon sales of gasoline and Diesel fuel to loggers are hitting on high.

Loggers and lumbermen are way up on the essential list, for wood, like copper, is a critical item. Alcohol is another critical item coming from wood as well as from petroleum.

Logging Methods Mechanized

Total demand for products made from wood has everybody and everything running in high gear. The word "gear" is a choice expression, for every operation possible in modern logging has been mechanized—powered by motors using gasoline or Diesel fuel. All this machinery also requires lubes and greases to keep going, so petroleum products sold to loggers are at an all-time peak. The woods are alive with gasoline and Diesel powered logging trucks, tractors, bulldozers, power saws for felling trees and saws for ripping them up, and with "log

Houdry processes provide higher octane, higher recovery of liquid products, more iso-butane.

These intrinsic advantages of the Houdry fixed-bed and the T.C.C. processes are enhanced by the vast and varied research and engineering facilities of the Houdry Laboratory. To its distinguished staff of chemists and engineers, Houdry licensees may submit for solution any problems relating to the production of aviation or motor fuels from any type of crude.

HOUDRY PROCESS CORPORATION
WILMINGTON, DELAWARE

Houdry Catalytic Processes and the T.C.C. Process are available through the following licensing agents to all American refiners, subject to approval by the United States Government.

E. B. BADGER & SONS CO.
Boston, Massachusetts

THE LUMMUS COMPANY
New York City, New York

BECHTEL-McCONE CORP.
Los Angeles, Calif.

jammers," and other hoists for handling uncut logs. Horses and mules are out. The only animals seen on a two-day trip here were two old nags being carted down the highway on a truck.

However, the average woodsman, as the oldtime lumberjack is now designated, no longer drives to work in his personal car, but group rides to and from his logging location in the carcasses of old school busses, which somehow still manage to run.

Thus, it is readily seen that logging at wartime speed has provided an entirely new and enlarged market for petroleum products, running into hundreds of thousands of gallons annually here on this small peninsula alone. Requirements even exceed those for farming for not much of that is done here.

A Trip Through the Woods

For an up-to-the minute view of fast logging and its demand of the oil industry for petroleum products, tag the heels of Mr. Tormala for a day while he makes the rounds, and talk to Waino Komula, president of U. P. Diamond, and O. A. Malila, secretary. They have been loggers most of their lives and are still at it. But they have not lived as long as William Johnson, (still another Finn, probably with a touch of Swede somewhere in the background), from whom Mr. Komula bought the U. P. Diamond Oil Co. on June 1, 1944. The "U. P." is short for Upper Peninsula, and as may be readily surmised by this time, the population here is largely Finnish, and the people are all proud of their ancestry.

"The Finnish people here," Mr. Tormala said, "are all sympathetic to Finland, but are Americans. I have lived here for 40 years and know all of them and they say 'Let Finland lay in the bed she made'—but if you want an argument, mention Russia."

Mr. Johnson, previous owner of the D-X distributorship here, is an old time logger. He managed a lumber camp for Henry Ford for many years, then went to logging on his own when Ford pulled out of the camp. Friends of Mr. Johnson's say government red tape in the lumber business, plus that in the oil business was too much for him after his son, Walter Johnson, who managed the U. P. Diamond, went into the Navy. Mr. Tormala, then one of his salesmen, helped Mr. Johnson, Sr., manage the business until it was sold to Mr. Komula. Mr. Tormala was then made treasurer and manager of the company. All of the former employes were retained, so there has been little change other than in ownership since the company was organized six years ago.

As to the part logging has played in the company's operations, a look at the records discloses that in 1941, sales to loggers were only 17% of the total. For 1943, this percentage climbed to better than 40%. Some of this increased percentage was due to rationing hurting service station sales; but sales to loggers jumped 127% over the 1941 figure, and undoubtedly has been a major factor in off-setting war time losses in service station gallonage due to rationing, which previously had been climbing because of increasingly strong Chamber of Commerce appeals from this scenic region in its bid for tourist trade.

Sales to commercial fishermen by the U. P. Diamond have continued steady during the past three and a half years, varying less than 10% at any time, but comparatively, the total is not large. Surprisingly, farm sales dropped sharply about 50% between 1941 and 1943, but 15% of that loss was regained during the first six months of this year. Apparently, when the demand for timber first came, farmers quit and went to logging for quick money and are now beginning to farm again.

It happens that the long spring thaw this year, followed by protracted rains, put a crimp in total sales for April, but they went up again in May and June as shown by Mr. Tormala's records. However, Mr. Tormala stated he was just a "li'l fellow" in the oil business, doing about 750,000 gal. annually of all products.

Getting back to the tall timber, sales to loggers of course include those to Mr. Komula, which amount to about 10% of the total sales to loggers, according to Mr. Tormala.

"How many pieces of equipment does it take to make up a sizeable logging outfit?" Mr. Komula was asked in order to get a picture of what logging meant to the oil business.

"I work from 100 to 150 woodsmen," he said, "which may be a little larger than the averag here, since on the peninsula all operators are independents with the bigger companies operating a little lower down in the state; but the equipment I've got is:

Four bulldozers — Diesel; five skidding tractors — gasoline; four Fordson hoists — gasoline; 15 trucks — gasoline; two jammers—gasoline; two jammers—steam; three gasoline power saws (crosscut).

Most of the timber cut in this vicinity

Eleven horse power gasoline motor powered cross-cut saw fells trees rapidly. A few of the saws are in use in the upper Michigan woods. The saws build muscle for they weigh 100 pounds

Gasoline powered "log jammer" or hoist swings heavy green logs aboard at a rail "landing" or loading yard near Hancock, Mich. Bark peeled from the hemlocks goes separately in box cars to tanneries

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View of the U. P. Diamond Oil Co.'s bulk plant in Hancock, Mich.

is hemlock, although there is a great deal of maple and birch being taken out too. Hemlock was one of the cheapest of lumbers before the war but the big demand for wood has brought the price up, and in addition to loggers like Mr. Komula who do nothing but logging, there are an estimated 60 or 65 small portable sawmills operating in this section also. These operating outfits usually consist of the sawmill powered by a model 40 Caterpillar; one bulldozer; two skidding tractors and two lumber trucks. They move in on a 40-acre tract of timber, clean out the mature trees and move to another spot.

All operations are now on a "selective logging" basis, that is only the mature trees are cut, which leaves 40 to 60% of the crop standing, Mr. Komula said, and does not denude the ground. The same woodland can then be cut over again in 10 to 15 years, as the trees left standing will mature in that time. "Woodpeckers" with a spray gun go through the timber marking the trees to be cut with a spot of green paint.

About 60 carloads, or half a million feet of lumber a day, is shipped out of the peninsula.

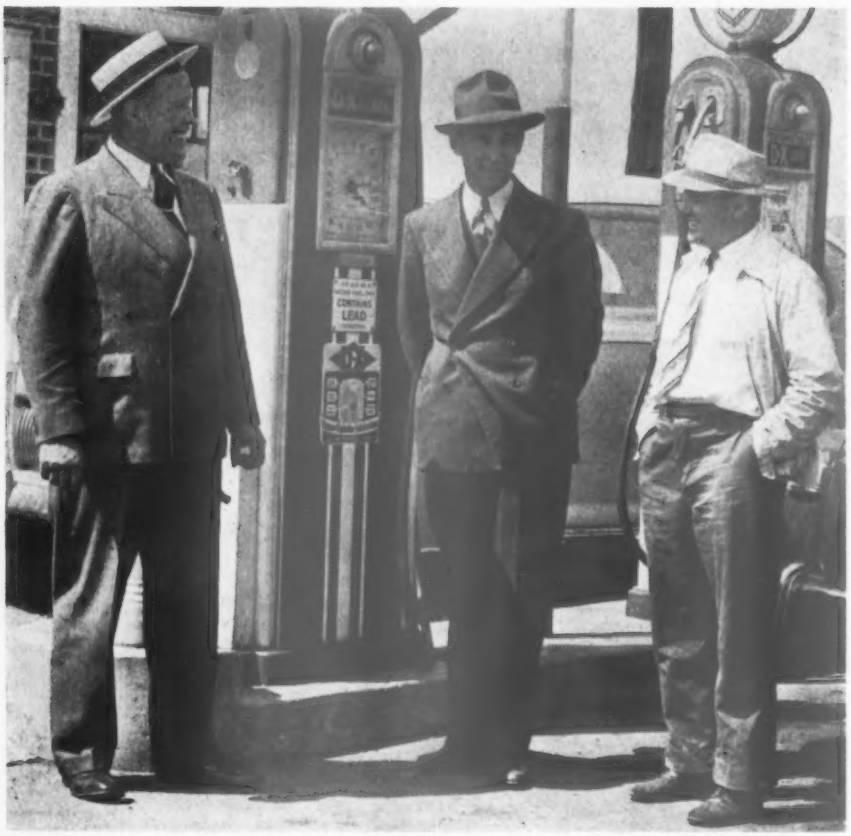
"What," we asked Mr. Tormala, "are you going to do when the war's over and the demand for timber and gasoline to cut it, slump off?"

"Imagine that!" he exclaimed, but he had his answer:

"I plan to buy up a bunch of service station sites and go after the tourist trade," he said. "Tourist trade was just starting when the war killed it, but it will come back again. I have five or 6 sites picked out now. We bought one site recently.

"Farming will also be good again," he continued. "Also, we have just rented a store location in Houghton, just across the canal from here, and have ordered a $10,000 stock of accessories and other merchandise from Firestone. We are going to open a Firestone store as soon now as we can. We have employed a manager already and he is attending Firestone's school. The store will be operated as a separate unit from U. P. Diamond Oil Co., at least for a while.

"Another thing that I think is coming to this section, are marine terminals," he went on. "There are plenty of good locations here on Portage canal, and 160 miles is too far and unnecessary to truck products. All of our products are now transported from Gladstone marine terminal in the Green Bay area."



Officials of the U. P. Diamond Oil Co., Hancock, Mich., left to right: Waino Komula, president and owner; O. A. Malila, secretary, and Fred Tormala, treasurer and manager

Not Correct About Cutbacks

Portage canals at each end of Portage lake near the center of the peninsula provide a short cut waterway across the 25-mile wide neck of land.

"How about your products now—getting all you want of what you need?"

"Just had notice from my supplier that our Ethyl has been cut in half," Mr. Tormala said. "I've notified our service stations to tell customers about it, but it won't hurt us much. If they can't get Ethyl, they'll buy housebrand. I also got notice that third grade white gasoline has been discontinued until further notice. It was used for lighting, not in cars, and I do not handle naphtha."

"How about prices?"

"Ethyl is 22.2c retail, housebrand, 20.2c and third grade when there is any, 20.2c, also. Very little price fight here—imagine that!"

"Need any equipment?"

"We will when we can get it. I read NPN regularly and always have, and for now when I need a tank or anything, I find it in the ads. I've ordered several during the past couple of years. I also read in NPN recently where the Petroleum Administrator's office in Chicago kept a list of used equipment."

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Modern war is the severest test ever given to oil and gasoline. It is the severest test, too, of the drums that carry the fuel — the drums that are the "supply base" for every flight.

Today, drums must travel thousands of miles — under all conditions. And every mile of the way the fuel inside must be guarded — guarded so well that not a drop of water or any impurity can reach the contents.

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Rubber Supply Ample, Says Dewey Resigning Post; Warns Manpower Lack Curbs Heavy Tire Output

NPN News Bureau

WASHINGTON—Claiming the synthetic rubber industry is now in full operation and providing ample supplies of rubber, Col. Bradley Dewey last week resigned as Rubber Director and recommended that his office be abolished. His resignation is effective Sept. 1.

"The need no longer exists for a highly integrated, hard-hitting organization cutting across properly established lines of responsibility of many agencies," Col. Dewey explained in a letter to Mobilizer Byrnes. "It is time to liquidate this wartime agency created for a special purpose," he said. "The need for it has been met. Today's need is for manpower."

Little doubt exists but what the suggestions will be followed. In a letter replying to Col. Dewey, Justice Byrnes stated that "I approve the recommendation you make, and will today recommend to the President that he rescind Executive Order No. 9246." This order, issued Sept. 17, 1942, created the Office of Rubber Director, following studies made by the Baruch Committee.

Construction Program Completed

In Progress Report No. 6, issued by Col. Dewey at the same time he made public his special report recommending dissolution of his office, it is revealed that the primary construction of all of the more than 50 plants in the original rubber program for the manufacture of butadiene, styrene, Buna S, Neoprene and Butyl has been completed and the plants are operating.

"The supply of synthetic rubbers is ample to provide for any presently foreseen requirement of essential rubber goods," the report states. "During the second quarter of this year, 209,004 long tons of synthetic rubbers were made. This was at the approximate rate of 836,000 tons per year.

"During the first six months of 1944 the stockpile of synthetics increased from 43,860 tons to 104,495 tons, an increase of 33,088 tons more than was anticipated. A stockpile of over 100,000 tons of crude rubber still remains."

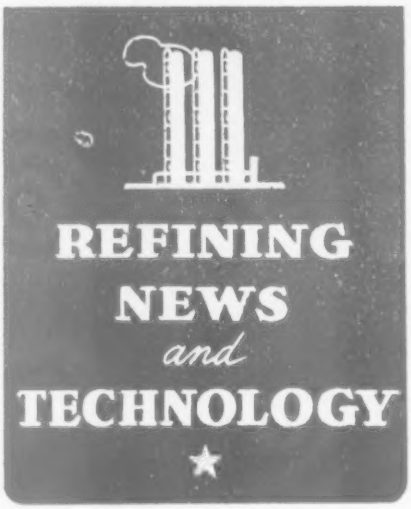
Only 6000 Workers Needed

For continuing general supervision of the rubber program, Col. Dewey suggested the establishment of a rubber division of WPB, organized and operated in the same general manner as WPB's steel and aluminum divisions. Such a division, according to Col. Dewey's recommendations, would be given "priority powers incident to the allocation of rubber goods and such regulation as the rubber goods manufacturing industry may need, as well as the determination of the industry's needs for products which are in short supply."

Biggest problem now in meeting rubber needs of the nation, according to Progress Report No. 6, is manpower. "Less than 6000 additional workers . . . stand between the present shortages of tires and an ability to meet all essential requirements."

"Once manpower is provided," the report continues, "production of tires will be limited only by available tire cords and carbon blacks. If these are supplied in accordance with requirements, it will be possible to build enough tires to meet military and essential civilian requirements."

In submitting his recommendations, Col. Dewey emphasized that "there is still work to be done if the country is to be kept on wheels." He warned that this apparent abundance of synthetic rubber "must not be taken as a signal for waste of rubber or rubber tires by use or speed."



Complete text of Progress Report No. 6 follows:

SUMMARY

1. The supply of synthetic rubbers is ample to provide for any presently foreseen requirement of essential rubber goods, but—

2. There is a serious shortage of the large heavy duty truck and bus, airplane and tractor tires. This reflects the shortage of manpower in the rubber goods manufacturing plants. By Presidential Directive, the responsibility for supplying new workers lies with the War Manpower Commission. *Less than* 6000 *additional workers*—about half the number to be strong, husky men—stand between the present shortage of tires and an ability to meet all essential requirements.

3. The production goal for passenger tires will be met, if adequate manpower and cotton tire cords are supplied. The goal of 22 million passenger tires is as large as the over-all war effort permits—especially in view of the demand for heavy cotton fabrics by the armed forces. In contrast with the manufacture of heavy duty tires, women can be used for the manufacture of passenger tires.

4. The present availability of synthetic rubbers should not lull the public into false security as to the necessity of taking care of its tires. Until more manpower, tire cords, carbon black, etc., are in sight than is now the case, it is but prudent for the owner of every tire to take care of it and worry as to where he will obtain his next tire.

5. The requirements of the Rubber Program for technically and scientifically trained men as well as certain skilled workers must continue to come before all but the must urgent and special manpower demands of the armed forces.

6. In short, the problems envisioned by the Baruch Committee when it wrote "If we fail to secure quickly a large new rubber supply our war effort and our domestic economy both will collapse" have been solved, but the demands of war are such that it may be many months before sufficient manufactured rubber goods, more particularly heavy duty truck and bus tires, are available to supply the needs of the civilian economy of the United States of America—a country "geared to rubber".

I. BASIC SITUATION

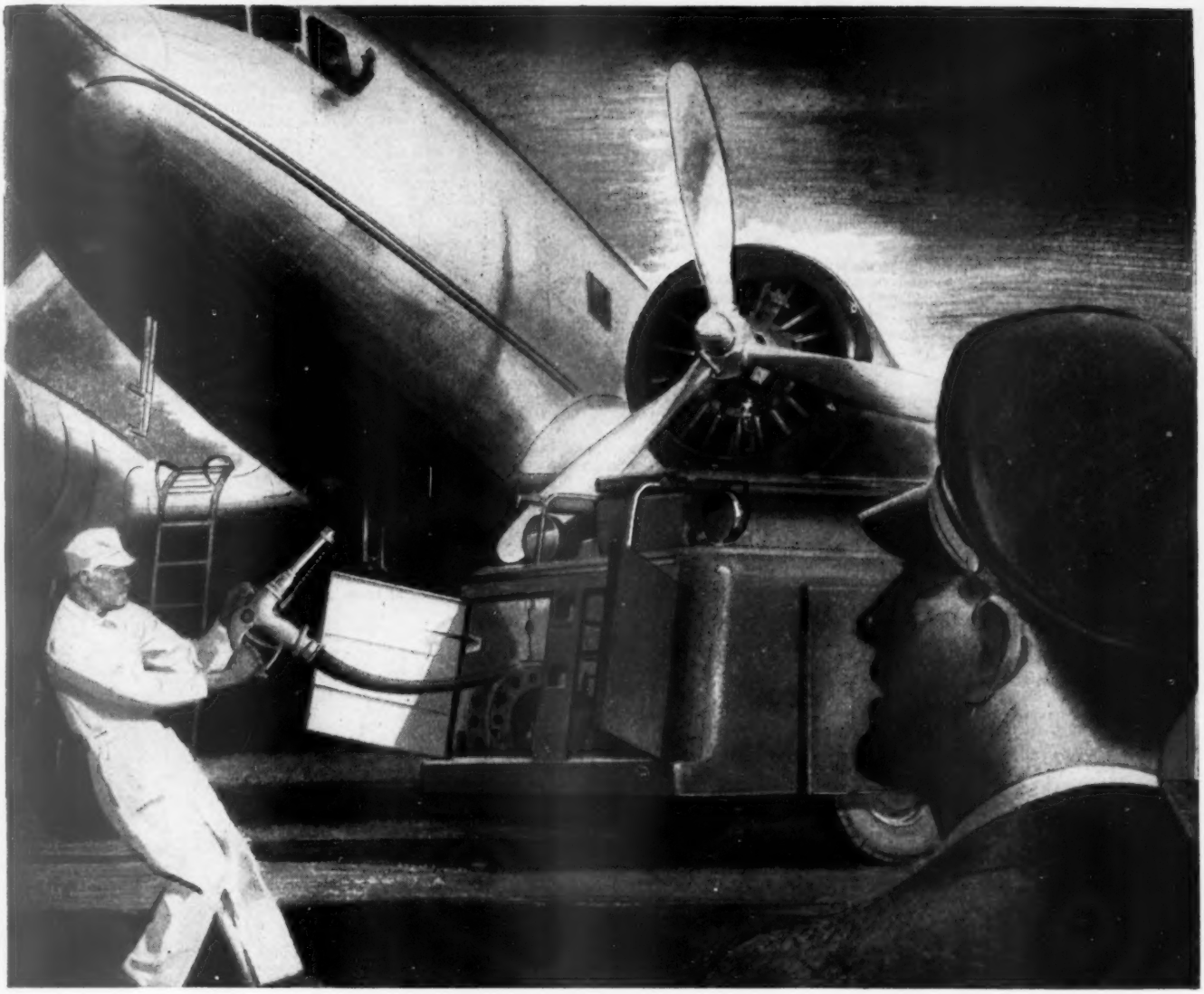
During the second quarter of this year, 209,004 long tons of synthetic rubbers were made. This was at the approximate rate of 836,000 tons per year. 186,035 tons of these were Buna S. During the first half year, a total of 376,087 tons of synthetic were produced, 315,452 tons were consumed and the inventory of synthetics rose during the first half of 1944 from 43,860 tons to 104,495 tons. This resultant inventory is 33,088 tons higher than was anticipated at the start of the year and, since production for the first half year was within 213 tons of that estimated in Progress Report No. 5, this increase in inventory was entirely due to inability of the rubber goods manufacturing industry to consume as much as had been estimated should be consumed. This was due to a shortage of manpower in the rubber goods manufacturing industry. The shortage of manpower is in part due to abnormally high absenteeism and low productivity of some workers, but in the main it is and has been due to a shortage of an adequate number of workers. By Presidential Directive, the responsibility for supplying new workers lies with the War Manpower Commission.

Despite the ample supply of synthetics, there is still a scarcity of manufactured rubber goods, especially of heavy duty tires to meet all the stated requirements of the military and essential civilian trucks and busses. Already this shortage is taking off the road trucks and busses that are badly needed for the war effort as well as the daily life of this country. As time goes on these shortages may seriously affect the ability of some industries to satisfy military demands. Pending the time when new workers are found and trained, only extraordinary and unusual effort on the part of workers and managements will make it possible to supply the most essential demands.

From the above picture it follows that the solution of the problem lies in obtaining more manpower. Once manpower is provided, production of tires will be limited only by available tire cords and carbon blacks. If these are supplied in accordance with requirements, it will be possible to build enough tires to meet military and essential civilian requirements. Once military requirements decline it will be possible to re-establish our civilian economy and fill our share of what will have to be supplied toward the rehabilitation of foreign countries.

Under the production priority pattern set up by this office, manufacturers may not build passenger tires at the expense of their ability to build a maximum of heavy duty military truck and bus, airplane and tractor tires. However, there are many areas where, though it has been impossible to obtain the heavier, stronger men necessary for the building of large tires, it is possible to obtain and train women and lightweight men for the building of passenger tires. Because of this availability of labor for the building of passenger tires, in the face of the shortage of that for heavy tires and because, except for the milling of the rubber compounds, the building of passenger tires uses different facilities, there is no apparent reason why the shortage of large tires should curtail industry's ability to manufacture the passenger tires scheduled for 1944.

At the start of the year it was planned to build 7,000,000 passenger tires during the first



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ARMY . . . Buckeye Figure 782U has been adapted to meet Army specification 50012F including strainer, grounding cable and dust cap.

NAVY . . . Figure 782N for carrier and land-based aircraft refueling—a longer tube and other modifications were made to conform to specification 33-N-1 (Int.).

COMMERCIAL . . . For use in connection with truck tank or fueling pit, Figure 782D has been designed to meet any aircraft refueling need.

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half-year—7,686,000 were built. Industry has been authorized to build up to 6,590,000 during the third quarter of this year. It is recognized that the cotton tire cord situation is so tight that any shortage or dislocation of inventory positions might make it difficult to build during the second half-year the 13,590,000 tires called for by the schedule. In some cases the machinery used for the making of the necessary cotton tire cords is identical to that needed for the making of yarns for tent duck. Military demands for tents are now so great that there is little hope of improvement in the tire cord situation and grave danger that any worsening of the manpower situation in the tire cord plants might cut into the production of passenger tires by several million tires. It is expected that the War Manpower Commission will watch the seriousness of this situation.

Progress Report No. 5 published March 17, 1944 stated that a short supply of Buna S had forced us to cut down on the availability of Grade C camelback made with a substantial content of Buna S, and to return to the use of all-reclaim Grade F camelback for the retreading of passenger tires. Since that time it has been possible to make not only Grade C, but also Grade A all-Buna S camelback available for the retreading of any tire. In view of the present availability of Buna S, there is no reason whatsoever to anticipate that this policy will have to be modified. The supply of high grade camelback is adequate to meet all military and civilian requirements.

Progress report No. 5, after emphasizing the necessity of caring for present tires and prolonging their life, stated: "In presenting this report it is emphasized that the estimates presented and the adequacy of supply of vital rubber products depend on the following:

"1. Completion on schedule of all construction and expansion programs for synthetic rubbers, allied programs for rayon and cotton tire cords, carbon black, alcohol, etc., as well as those for new rubber industry manufacturing facilities.

"2. Availability of an adequate supply of highly productive labor and well-trained technical staffs—chemists, chemical engineers, physicists, etc.

"3. Freedom from work stoppages and transportation delays at plants making rubber products, synthetic rubbers, rayon and cotton tire cords, carbon blacks, rubber chemicals, alcohol, butylenes, etc.

"4. Maintenance of crude imports at or above projected levels."

It went on to emphasize:

"There are no hedges against failure or delay in the performance of programs for which either we or others are responsible."

Except as altered by the completion of the construction and expansion programs for synthetic rubbers and some of the rubber industry's new manufacturing facilities, these conditions still hold.

Progress Report No. 5 discussed many parts of the Rubber Program in great detail. It is not the intention of this Report to duplicate or deal with those parts which are essentially unchanged or adequately covered in previous reports.

II. STATUS OF SYNTHETIC RUBBER AND ALLIED PROGRAMS

A. *Construction.*—The primary construction of all of the more than 50 plants in the original Rubber Program for the manufacture of butadiene, styrene, Buna S, Neoprene and Butyl, has been completed and the plants are operating. A 14,000 ton per year capacity expansion of the Neoprene plant at Louisville, Kentucky, is under way and will be completed late in December. Secondary construction incident to the providing of additional steam, water purification units, by-product recovery systems, etc., are under way at many of the plants, but in most cases the components for them are already on the ground and they will be completed within the next few months without serious interference with any other important programs.

A privately financed 10,000 ton per year butadiene plant has been approved and is under construction at Bishop, Texas. This plant is being built by the Celanese Corporation of America using the aldol process and will employ petroleum gases as the basic raw material. It is expected that this unit will be in operation by the early part of next year. Pilot plant work indicates that the process will operate satisfactorily and produce butadiene at low cost.

B. *Costs.*—A supplementary report to be published in late August, will give some of the more pertinent data on the costs of construction and the operating efficiency of the plants. It will also give data as to proven and estimated postwar costs of the resultant products.

C. *Production.*—Based on experience gained to date and the present requirements and supply picture, it now appears that the production of butadiene by various processes in 1944 will be as shown in Exhibit B. This chart reflects the effect of a diversion of butylenes to the aviation gasoline program during July and August. This diversion—made possible by the demonstrated over-capacity of the butadiene-from-alcohol plants and the availability of alcohol—was agreed to in order to help fill the emergency requirements of Army and Navy aviation resulting from the flying of more than originally forecasted missions over Europe. During the fourth quarter, it is planned to curtail production of butadiene from alcohol since it is expected that the butylenes will no longer be critically needed by the aviation program and the manpower situation in the rubber goods manufacturing plants will govern the amount of synthetics that will be needed. Obviously, with the butadiene from alcohol costing about five times as much as that from butylenes, only the great need for aviation gasoline justifies any but a minimum use of butadiene from alcohol.

The actual and estimated production of Buna S, Butyl, Neoprene, and Buna N from January 1943 through June 1945 is shown in Exhibit C.

In order to realize these estimates, the irreplaceable technical and operating personnel of the various plants must be kept intact at all times. This need must govern deferment policies.

D. *Allied Programs.* — Assurances received from those responsible for supplies of tire cords, carbon black, etc., lead to the conclusion that unless the manpower situation in the rubber goods manufacturing plants improves faster than now seems probable, supplies of these materials, though short, will be adequate

Exhibit B—Butadiene Production by Sources by Quarters, 1943—1944

From Progress Report No. 6, Office of Rubber Director
(In Thousands of Long Tons)

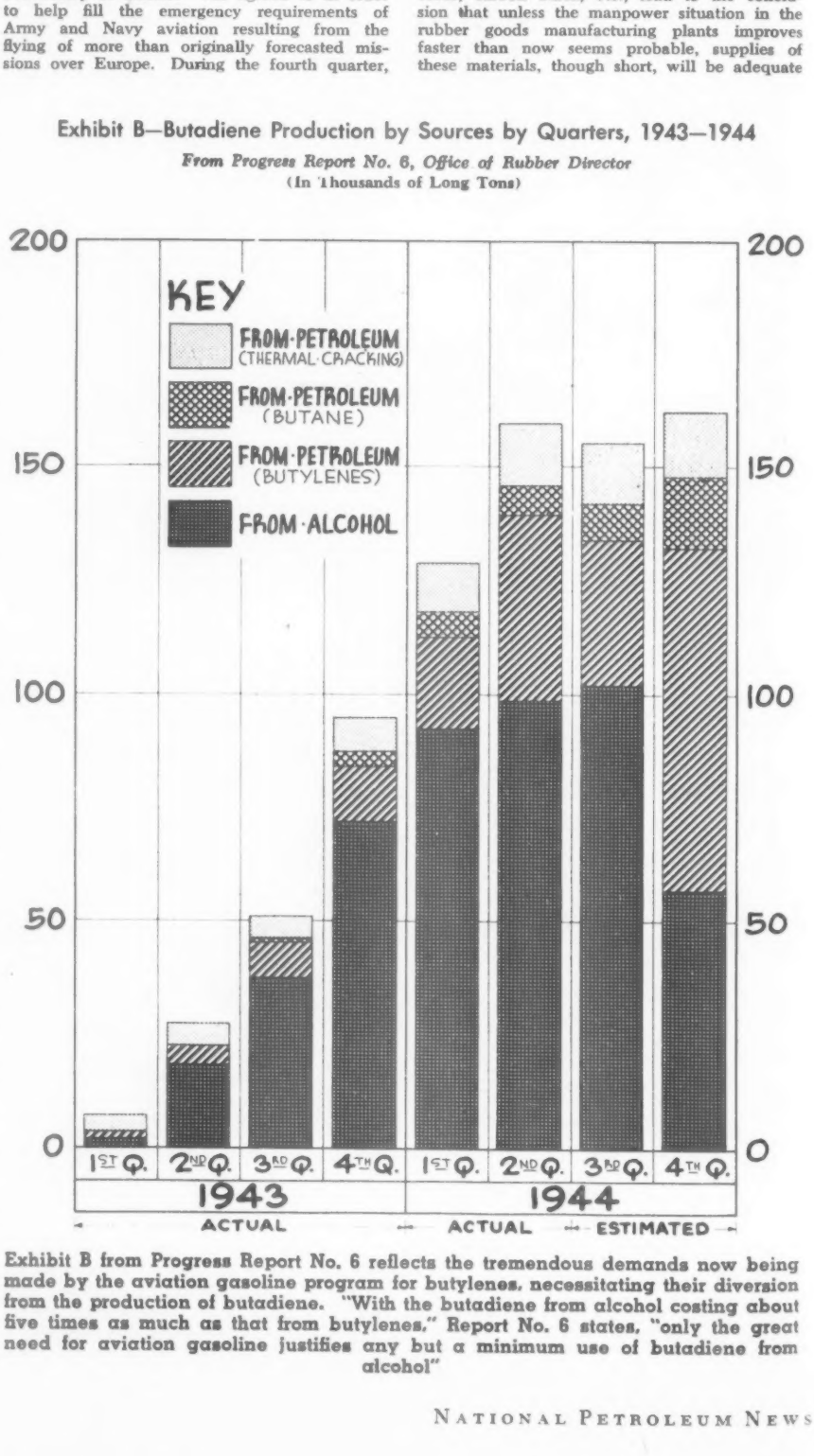


Exhibit B from Progress Report No. 6 reflects the tremendous demands now being made by the aviation gasoline program for butylenes, necessitating their diversion from the production of butadiene. "With the butadiene from alcohol costing about five times as much as that from butylenes," Report No. 6 states, "only the great need for aviation gasoline justifies any but a minimum use of butadiene from alcohol"

for the production programs now contemplated.

III. ADEQUACY OF TIRE PRODUCTION PLANS VERSUS REQUIREMENTS

To the extent that tire facilities can be interchanged, the following production, priority pattern has been set up by this office to govern the production of tires by each company until the full requirements in each group and sub-group have been satisfied in the order listed. For example, no facilities—equipment, materials and labor—can be used to produce Group 2-f tires until full capacity of the facilities have been utilized to make the requirements of Group 2-e tires.

Production Priority Pattern (as listed in Rubber Order R-1)

1. Airplane tires and tubes:
   a. Large size tires, built on truck equipment.
   b. Small size tires, hand built or built on industrial pneumatic equipment.
   c. Other small size tires, built on passenger equipment.
   d. Tubes.
2. Truck and bus tires and tubes:
   a. Combat tires.
   b. Extra large size tires, 16.00 and larger cross-section.
   c. Large size tires 9.00 through 14.00 cross-section.
   d. Medium size tires (dual bead), all 10-ply up to and including 8.25 cross-section.
   e. Small size tires (single bead), 8-ply and under, and 9.00 x 16, 8-ply.
   f. Tires with 15 inch and 16 inch rim diameters, up to and including 7.50 cross-section (4, 6 and 8-ply only).
   g. Solid tires.
   h. Tubes.
3. Tractor-implement tires and tubes:
   a. Large size tires, over 7.50 cross-section.
   b. Front and small size tires, up to and including 7.50 cross-section.
   c. Tubes.
4. Industrial tires and tubes:
   a. Bogie rollers.
   b. Pressed-on solids.
   c. Cured-on solids.
   d. Pneumatic tires.
   e. Tubes.
5. Camelback and repair materials:
   a. Truck type and heavy duty.
   b. Passenger type.
6. Passenger and motorcycle tires and tubes:
   a. Tires.
   b. Tubes.
7. Bicycle tires and tubes:
   a. Tires.
   b. Tubes.

The following tabulation shows:

1. The estimated requirements of all Claimants.

2. The estimated capacity of the Industry—assuming full use of all facilities.

3. The actual output for the first two quarters of 1944 and estimates for the next four quarters based upon labor conditions and manpower shortages now experienced by the individual companies in the Industry.

Group 2—Truck and Bus Tires

(Thousands of units)

Calendar quarter	Total estimated requirements	Capacity based on full use of all facilities	Actual and estimated productions on basis of present conditions
1944:			
First quarter	4,589	3,800	[a]3,598
Second quarter	5,253	4,227	[a]3,620
Third quarter	4,711	4,636	3,750
Fourth quarter	4,786	4,816	4,000
Year 1944	19,339	17,479	14,968
1945:			
First quarter[b]	5,241	5,176	4,250
Second quarter[b]	5,482	5,395	4,350

[a]Actual production.
[b]Includes high-flotation program.

The use of facilities for building large size airplane and combat-runflat tires competes directly with those for Group 2-c heavy duty truck and bus tires. Therefore, the requirements for Group 2-c tires cannot be met until the available facilities have been fully manned and used for the manufacture of tires in the higher groups. However, with the exception of Group 2-c the most essential requirements are being met, even under existing labor conditions. The table below sets forth the position of tires in this group.

Group 2-c—Truck and Bus Tires (9.00 Thru 14.00 Only)

(Thousands of units)

Calendar quarter	Total estimated requirements	Capacity based on full use of all facilities	Actual and estimated productions on basis of present conditions
1944:			
First quarter	788	586	[a]576
Second quarter	1,095	688	[a]608
Third quarter	1,000	876	663
Fourth quarter	1,000	995	750
Year 1944	3,883	3,145	2,597
1945:			
First quarter[b]	1,050	1,030	900
Second quarter[b]	1,100	1,097	950

[a]Actual production.
[b]Includes high-flotation program.

Inasmuch as there is a sufficient supply of materials to fill the requirements, *it is obvious from the above that the production of needed heavy duty truck and bus tires is dependent upon manpower to man the facilities already provided and building.*

The above table reflects a newly programmed expansion of facilities initiated to meet new Army needs of so-called special purpose high-flotation truck and bus tires. In connection with the shortages shown in these tables, it is perhaps worthy of comment that enough tires are being made to meet the stated replacement requirements for both military and civilian use, but not enough to meet the stated replacement requirements together with those of the integrated vehicle program. The extent to which it may be advisable to defer original equipment programs to release tires for civilian replacement is being studied by the War Production Board.

The procedure necessary to distribute the output of all tire factories is based upon claimant agency allocations and directions to the industry to produce and ship in accordance with distribution patterns established by agreement with the various claimants.

The following tabulation shows in long tons the actual use of crude and synthetic rubbers during 1943 and through first half of 1944, estimates of consumption in the second half of 1944 and first half of 1945 based upon the foregoing situations and present production plans. In this table the figures for exports include the rubber contents of exported fabricated rubber goods and the figures for other consumptions are correspondingly adjusted.

Estimates of 1945 Needs*

	First quarter (estimated)	Second quarter (estimated)	Total ½ year (estimated)
Military	93,000	93,000	186,000
Trucks and busses	46,000	46,000	92,000
Passenger size tires	47,000	46,000	93,000
Other indirect military and civilian	20,000	20,000	40,000
Total U. S.	206,000	205,000	411,000
Exports	36,000	36,000	72,000
Canada	11,000	11,000	22,000
Grand total	253,000	252,000	505,000

*Covers first six months only.

IV. CONVERSION TO SYNTHETIC RUBBER PROGRAM

The conversion program can only be considered finished when the minimum requirements of crude rubber are no greater than the income of this commodity. Large sizes of truck and bus tires and military tires including aircraft are consuming at present more than 60% of the crude rubber that is being used. The projected conversion schedule calls for continued reduction of crude rubber in these sizes. However, even in the ultimate program a large percentage of use of crude rubber will still be in these tires.

Tires and tubes required by the Ordnance Department are 82% converted to synthetic. The conversions that are planned for the next few months will bring this to 85%. It is the consensus of opinion of those responsible that 86% conversion to synthetic will be the optimum that can be accomplished. The actual monthly consumption of crude rubber for Ordnance items is estimated at 3,230 tons per month during the third quarter, and 2,438 tons for the fourth quarter. The only Ordnance products other than tires that require

Use of Crude and Synthetic Rubbers in 1943-1944*

	1943 First quarter (actual)	Second quarter (actual)	Third quarter (actual)	Fourth quarter (actual)	Total (actual)
Military	66,000	66,100	68,300	71,000	271,400
Truck and busses	17,100	19,800	23,500	29,200	89,600
Passenger size tires	1,000	4,300	13,200	28,700	47,200
Other indirect military and civilian	6,600	7,600	8,900	9,400	32,500
Total United States	90,700	97,800	113,900	138,300	440,700
Exports	11,400	13,000	16,100	30,100	70,600
Canada	98,300	8,300	7,500	5,200	30,300
Grand total	111,400	119,100	137,500	173,600	451,600

	1944 First quarter (actual)	Second quarter (actual)†	Third quarter (estimated)	Fourth quarter (estimated)	Total (estimated)*
Military	78,000	74,000	84,000	89,000	325,000
Truck and busses	36,000	43,000	46,000	48,000	173,000
Passenger size tires	23,000	27,000	41,000	43,000	134,000
Other indirect military and civilian	16,000	15,000	16,000	18,000	65,000
Total United States	153,000	159,000	187,000	198,000	697,000
Exports	35,000	42,000	35,000	35,000	147,000
Canada	9,000	9,000	10,000	11,000	39,000
Grand total	197,000	210,000	232,000	244,000	883,000

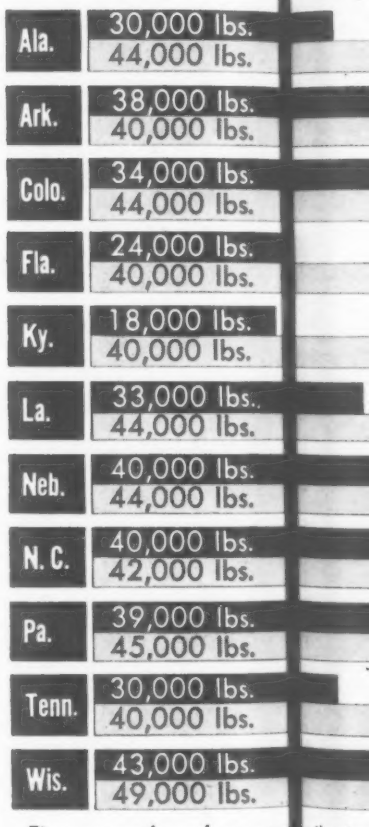
†Includes preliminary data for June.
*Third and fourth quarter of 1944 estimated.

WILL VICTORY MA
RETREA

DO YOU REALIZE that when the day of Victory arrives, many Truck-Trailer operators hauling petroleum and other daily necessities may be forced to cut their loads in half?

Sounds ridiculous, doesn't it? But, this is exactly what would be required of them after V-Day in the State of Kentucky, for example, unless in the meantime more liberalized laws, which were adopted "for the duration only", are made permanent measures.

Yet, Kentucky isn't the only State with restrictive laws which have been modified to meet Army and Navy requests for the free flow of war materials across State lines. There are 17 other States whose liberalizing laws haven't yet been made permanent.

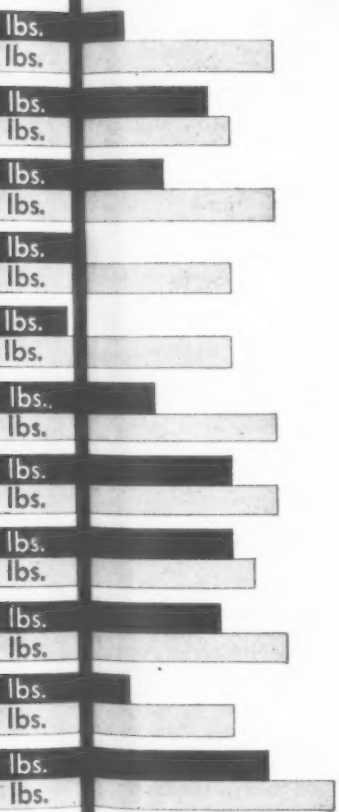


Figures are based on a pro estimate allowances for a Truck-T

Gross-weight limit still on statute books.

Temporary war-time allowance.

★ "Engineered Transportation"
Reg. U. S. Pat. Off.



on a pro estimate of gross weight
ces for a Truck-Trailer.

In addition to the States listed, seven—Connecticut, Delaware, Indiana, Iowa, Maine, Massachusetts and North Dakota—have temporarily lifted other restrictive size and weight laws for the duration.

It is logical to assume that those who were responsible for the spawning of the hodge-podge of crippling laws in the first place, will be interested in seeing that the shackles are once again clamped on, in an effort to strangle highway transportation.

How would the restrictions of a back-sliding State affect you? Here is the answer:

Anything which hampers the efficient operation of motor trucks and trailers, regardless of which State applies the restriction, means higher costs of living and higher costs of doing business for all America—because transportation charges are included in the price you pay for the food you eat, the clothes you wear and the other goods you buy.

What can you do about it? You can insist to your Congressmen and your Legislators that the more liberal, uniform wartime size-and-weight standards for Truck-Trailers be adopted as permanent laws, and that all other regulations which are not in the public interest be **entirely eliminated.**

Removing trade barriers for the duration is vital. However, that's not enough. They should be removed permanently!

Send for the interesting booklet "Are the United States United?" (third edition) or pick up a copy at your nearest Fruehauf Branch. Know how your State stands on the subject of trade barriers. It's important to you.

World's Largest Builders of Truck-Trailers

FRUEHAUF TRAILER COMPANY • DETROIT 32

Service in Principal Cities

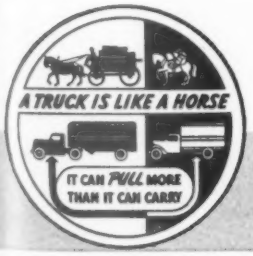
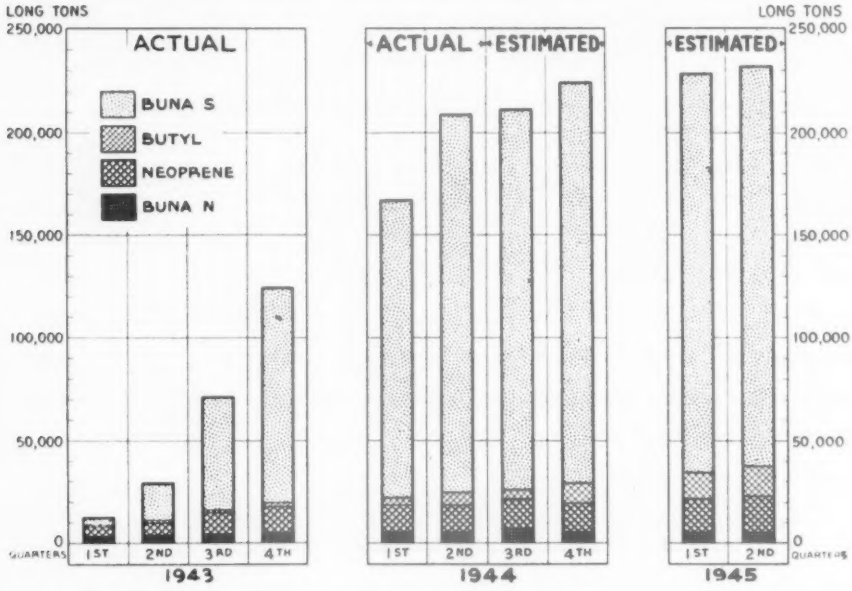


Exhibit C—Estimated Synthetic Rubber Production* of Buna S, Butyl, Neoprene and Buna N by Quarters, January 1943-June 1945

From Progress Report No. 6, Office of Rubber Director

	1943					1944					1945		
	1ST	2ND	3RD	4TH	YEAR TOTAL	1ST	2ND	3RD	4TH	YEAR TOTAL	1ST	2ND	6 MO. TOTAL
BUNA-S	3,102	18,792	56,741	106,146	184,781	145,641	186,035	185,700	195,000	712,376	195,000	195,000	390,000
BUTYL	35	393	364	581	1,373	3,081	3,928	4,560	9,590	21,159	12,430	15,120	27,550
NEOPRENE	4,372	5,853	10,049	13,329	33,603	13,962	14,991	14,250	14,250	57,453	16,250	17,250	33,500
BUNA-N	2,977	3,335	4,063	4,112	14,487	4,399	4,050	6,550	5,050	20,049	4,850	4,850	9,700
TOTAL SYNTHETIC	10,486	28,373	71,217	124,168	234,244	167,083	209,004	211,060	223,890	811,037	228,530	232,220	460,750



(*Includes Capacities of Private Plants)

large quantities of crude rubber are tracks and bogies for tanks. These had been converted mostly to synthetic, but experience in combat resulted in changes of vehicle design which has necessitated a temporary return to the use of crude rubber.

Satisfactory progress has been made during recent months on aircraft items including tires and tubes. The program which is outlined for the next three months will bring the entire aircraft program close to the ultimate goal.

Military and essential civilian tires and tubes, tracks and bogies for tanks and fuel cells for aircraft consume approximately 85% of the crude rubber that is being used. Military items such as special types of wire and cable, hose, medical and drug sundries and proofed fabrics for specialized uses require most of the additional crude rubber that is being allocated. There are a few items where no synthetics now available have been found adequate, but in most instances a conversion program is under way.

The consumption of crude rubber during the first half of 1944 was well within the estimates of our conversion program. The conversion schedule which is projected for the last six months of 1944 can be accomplished without seriously affecting production or performance of products. Assuming that there is no failure to carry out the conversion program that has been projected, and that this country receives the quantities of crude rubber that have been promised, this nation will be able to live within its income during 1945. However, despite the above it must be realized that to a limited extent in some products we are sacrificing quality and quantity in order to conserve crude rubber. The availability of a greater amount of crude rubber would, therefore, at this time enable us to turn out greater quantities of rubber products with existing equipment and manpower.

V. SCRAP AND RECLAIM RUBBER

The following table shows the tonnage of scrap rubber originally collected, its cost, amount received for it and the probable loss incident to the whole transaction after sale or disposal of the miscellaneous scrap remaining in the storage yards on Dec. 31, 1944.

The value of this scrap during the critical years just past was immeasurable. It permitted the manufacture of the reclaimed rubber which saved the day while the synthetic plants were building and which continues to play a vital role.

In addition to the residue of scrap tires now on hand, the wearing out of tires now on cars will bring to the scrap market some additional thousands of tons of scrap. However, from now on most scrap tires will have been retreaded with synthetics and the reclaiming industry will be faced with new problems incident to the reclaiming of synthetic rubber scrap. Some in the reclaiming industry have made great progress in the development of methods for doing this. They have not as yet developed entirely satisfactory methods for reclaiming mixtures of synthetic rubber and crude rubber, such as are found in the truck and bus tires now being made as well as in crude rubber passenger tires which have been retreaded with synthetics. Inasmuch as the future of these companies is so dependent upon the solution of this problem, we can safely rely upon them to do the necessary work to perfect their processes.

VI. MANPOWER

Progress Report No. 5 stated, "Manpower continues to be a serious problem throughout the industry and the achievement of maximum production of rubber products is being impeded by manpower shortages in certain critical labor areas." This is doubly true today. *Manpower is the unsolved problem.* The present production of finished rubber goods is and will be controlled by available manpower and the productivity of labor now on the job.

Recognizing the seriousness of this situation the War Department has arranged for the return from the Army of certain heavy duty tire makers over 30 years of age still in this country. The Inter-Agency Committee on Occupational Deferments has recognized the needs of the rubber industry. The industry has moved a considerable amount of production out of critical labor areas into other less critical areas. The Army has co-operated with drives to help reduce absenteeism and leaders of management and labor are working towards the greater efficiency and productivity which only their efforts can realize.

VII. DRIVING SPEED

Despite all of the warnings issued in previous Progress Reports, in various press releases and in radio programs, there has been an unfortunate tendency for the public to feel that the availability of synthetic rubber permits relaxation of the speed limit. The American Automobile Assn. commented upon this in a recent report and several states have recently removed the wartime speed limit. With the manpower and tire cord situations as critical as they are, this relaxation of the speed limit may be costly.

VIII RATIONING

In any consideration of rationing, everyone is, of course, interested in "How long before tires will be available for passenger cars?" The synthetic rubber is now available, but shortages of manpower and cotton tire cord will set the limits of production. The extent to which these may supply the demand sufficiently to permit of further relaxation of rationing restrictions is highly debatable. Some feel that as long as gasoline is rationed as at present, the demand for new tires will decline so that rationing can be relaxed. Others feel that the tires now on the road are rapidly wearing out and that even with 22 million passenger tires built this year, the needs of the public will be greater next year than this year. The extent to which the speed is held down and tires are given utmost care by the public will help determine the date that rationing can be further relaxed.

Several changes have been made in the Tire Rationing Regulation of the Office of Price Administration since the last Progress Report. The purpose of the changes has been to assure the proper distribution of available supplies of tires and to remove restrictions wherever possible.

The more important changes have been:

1. *Simplification of inventory reporting by tire dealers.* Though all tire dealers are required to maintain inventory records of tires, only certain dealers are required to report such

Projected Scrap Rubber Balance Sheet as of Dec. 31, 1944

	Short tons collected	Cost of scrap	Tons sold*	Amount received
Tires and tire parts	873,728	$28,271,937	873,728	$17,449,410
Tubes	31,965	1,040,229	31,965	6,346,877
Miscellaneous	242,405	7,838,868	71,834	2,200,000
Total	1,148,098	37,151,034	977,527	25,996,287
Cost of handling, storing and selling				$14,797,892
Total cost				$51,948,926
Net loss				$25,952,639
Balance miscellaneous scrap (tons)				170,571

*Includes estimates sales for balance of 1944.

The miscellaneous scrap on December 31, 1944, may be considered as of little or no value. To liquidate this scrap and close the storage yards at or prior to June 30, 1945, may cost approximately $2,000,000, giving a total government scrap rubber net loss of about $28,000,000.

inventories to OPA. By selecting certain dealers to report inventories, adequate control and information is secured and the large majority of dealers are relieved from the necessity of reporting.

2. *The restriction limiting dealer inventories was removed.* The original purpose of this restriction was to distribute slow-moving stocks. The purpose was accomplished and the restriction removed.

3. *So called "factory second" passenger tires classed as Grade III.* The slow movement of factory seconds and the scarcity of used and recapped Grade III passenger tires warranted the reclassification of factory seconds from Grade I to Grade III. They are now available to persons ineligible for new passenger tires.

4. *Elimination of periodic inspection of passenger tires.* After a year and a half, the primary objectives of the regulation have been accomplished. The elimination of the regulation will materially ease the burden on the motorist. Inspection and proof of need, however, are still required in order to secure a replacement tire.

5. *Broadening eligibility for passenger tires.* Passenger vehicles for which valid supplemental gas rations (generally "B" and "C") have been issued were made eligible for new passenger tires (Grade I). Passenger vehicles for which "A" gas rations only have been issued were made eligible for Grade III tires —used, recapped and factory second passenger tires.

6. *Transfer of new passenger tires by manufacturers without certificate.* In order to facilitate the immediate distribution of new passenger tires by manufacturers to dealers, manufacturers were permitted for a limited time to transfer new passenger tires to dealers without certificate. Inventory control was maintained through notification to OPA of each transfer.

7. *Invalidation of certificates; non-transferability of replenishment portions of certificates.* Replenishment portions of tire certificates dated prior to April 1, 1944 were made invalid after July 15, 1944, unless they were in the possession of the manufacturer on July 15. Transfer of replenishment portions of tire certificates was prohibited. This provision gave a needed flexibility in the distribution system to adjust inventories. The need for inventory adjustment largely disappeared with increased production.

8. *Inner tubes were removed from rationing restrictions.* The inventory and production of all inner tubes showed a supply adequate to meet anticipated demand. This position warranted the removal of rationing restrictions from the sale of inner tubes. It will also aid in the conservation of tires, since a good tube properly inflated prolongs the life of a tire.

IX. RESEARCH AND DEVELOPMENT

The Akron pilot and evaluation laboratories owned by Rubber Reserve Co. are now being operated by the University of Akron and six pilot laboratories are being built at various copolymer plants. As time goes on it becomes more and more evident that the most important goal of the research efforts must be so to modify Buna S or develop a new polymer that (1) it will evolve less heat, (2) it will not lose so much of its strength at elevated temperatures and (3) when compounded for maximum strength it will have such resiliency that it will permit making tires that not only will heat no more than the old crude rubber tires, but will give the vehicle all of the "soft ride" sought for in the pre-war tire. Four avenues of attack have shown some promise; two considerable promise. Some test tires have been run. Other tires will be made and run in the coming months. This research work should be carried out with all possible vigor, irrespective of any guesses as to when the war may end. Synthetics will be needed after the war. A large part of the synthetic rubber industry must and will live.

X. CRUDE RUBBER

Responsibility for the activities of Rubber Development Corporation was given to the Office of Economic Warfare, predecessor of the Foreign Economic Administration, by Presidential Directive July 15, 1943. Production from South America has been disappointing;

SPEED
AND RELIABILITY
Speed is a vital factor in readying our mighty bombbers and fighters for their all-important missions. And at army air bases all over the world, MILVACO valves and fittings are helping to feed the fuel that keeps 'em flying — saving precious minutes where time means most.
MILVACO valves and fittings are designed and engineered to provide a higher speed discharge in refueling operations — to maintain a smooth, constant, full and faster flow.
And this same precision workmanship, accuracy and unfailing dependability, now serving so many military uses, are embodied in MILVACO'S regular line of commercial valves and fittings for the petroleum industry which are now being produced for your more urgent needs.
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today it appears to this Office the prospects for 1945 are little or no brighter. As noted at the end of the section on conversions, the need for crude is so great that it is hoped no pains will be spared to obtain all possible. The Foreign Economic Administration has recently advised this office of the termination of their project in Haiti for the development of cryptostegia.

On March 19, 1943, this Office advised the Secretary of Agriculture that it did not feel that the need for guayule, which requires from 2½ to 4 years before it may be harvested commercially, was sufficiently pressing to warrant the use of irrigated, highly productive lands. As a result, expansion was suspended.

Funds for the cultivation, processing and research of guayule shrub are made available annually by the Congress. Present appropriations do not provide for further planting. The maximum amount of shrub which may be processed by renovating the existing mill at Salinas, California and building an additional processing mill at Bakersfield, California will be harvested and processed between now and the end of the fiscal year, June 1945. The Department of Agriculture estimates that approximately 600 long tons of guayule will be produced by then. Plans have been prepared whereby approximately 26,000 long tons of guayule rubber may be processed from existing acreage. Whether or not this total amount will ever be produced is dependent upon future appropriations by the Congress.

Until imports of crude are sufficient to supply all needs for crude rubber, it is inconceivable that any available source be destroyed and for this reason, this Office has, therefore, recommended holding the present plantings until at least June 30, 1945.

XI. PRICING OF SYNTHETICS AND CRUDE

This Office is on record that the complications incident to a two price system for synthetics under present regulations should be replaced by a single price system at the earliest possible moment and that this single price system should reflect insofar as possible the probable future costs of the various synthetics. No one type of synthetic or crude rubber should be subsidized at the expense of the others.

XII. RUBBER ORDER R-1

The regulations which govern the use of crude rubber and various synthetics are covered by Rubber Order R-1. This is drawn in such a way as to minimize unnecessary restrictions upon industry and yet, by grouping products according to careful weighing of conditions and essentiality of products, make it possible through the issuance of further amendments to remove restrictions as rapidly as new conditions permit, as well as to tighten them in the event of unexpected emergencies. If it were not for the present manpower situation, it would be possible to remove practicaliy all of the restrictions which now exist, except as they are necessary to protect against the use of crude rubber for any non-essential items or for any use which can be adequately filled by synthetics.

XIII. INTERCHANGE OF INFORMATION WITH THE U. S. S. R.

For the past year and a half there have been many negotiations looking toward a more complete interchange of information with the Union of Soviet Socialist Republics on the manufacture and use of synthetic rubbers. They have received a general insight into our synthetic rubber industry and have made contracts for technical and engineering plants for the manufacture of synthetic alcohol from petroleum and the manufacture of Neoprene, which does not keep well enough in unvulcanized form to warrant shipping from here. We, in turn, have received some information as to the basic nature of the processes used by the Russians.

Negotiations incident to a possible two-way interchange of more complete information, under conditions which recognize that there is no longer the same need for this information as existed a year and a half ago, have been proceeding slowly.

XIV. ORGANIZATION OF THE OFFICE OF RUBBER DIRECTOR

From the start, the Office of Rubber Director has been staffed with men of proven capacity to discharge the type of responsibility given them. Every effort has been made to operate as a business institution with a minimum of personnel and without unnecessary red tape or duplication of effort. As a result of these policies, it was possible during the fiscal year ended June 30, 1943, to turn back to the Treasury a very substantial percentage of the budget set aside for the payment of salaries and in the next fiscal year to turn back 35% of the budget voted by the Congress. The budget on which the office is now operated for the current fiscal year is only $646,000, as compared with an annual rate of $2,240,000 during the fiscal year ended June 30, 1943.

At the peak of its activities the Office employed 505 people, of which some were part-time consultants. Throughout the last 12 months this total was steadily reduced. There are now less than 250 on the payroll.

Within the organization there has been a full delegation of specified responsibilities to Assistant Directors in charge of (1) Operations (2) Research and Development (3) Conversions from Crude Rubber to Synthetics and (4) Plant Construction. It is to the personnel of the office and their loyalty to the purposes of carrying out the recommendations of the Baruch Report that any success of this office must be attributed.

Arthur Pew Tells Sun Oil Unionists at Toledo How 100-Octane Is Hammering War Targets

Special to NPN

TOLEDO—Without the principle of catalytic cracking and its commercial development, the production of 100-octane aviation gasoline in the volumes required by this war would have been impossible, Arthur E. Pew, Jr., vice-president, manufacturing department, Sun Oil Co., told a meeting of the company's workers at Toledo, July 28.

Catalytic gasolines are the best components for blending with alkylate to produce the volumes of aviation fuel required, he stated. Fuels thus produced make possible shorter take-offs for fighter planes and greater range and speed. The greater bomb load carrying capacity these fuels provide, said Mr. Pew, means that 1000 four-engine bombers, flying to a target 1000 miles distant, can carry 5,000,000 more pounds of bombs than could be carried with the 91-octane fuel used before the war.

By aggressively pushing the development of the Houdry catalytic cracking process, Sun's refineries at Marcus Hook and Toledo, combined, had the largest catalytic cracking capacity of any two refineries in the world on the day the Japs attacked Pearl Harbor, he asserted.

Reviews 'Number 1 Job'

"To change these plants immediately to the production of aviation fuel was our Number One Job," said Mr. Pew. "Within a few weeks after Pearl Harbor, the Marcus Hook and Toledo refineries had tripled their prewar production of aviation base stock and after four months had raised it to five times the prewar output. During this period the enemy submarines operating on the East Coast caused Marcus Hook crude runs to be materially reduced, but despite this the record was made."

Sun Oil Co. also started a construction program involving more than $21,000,000 for aviation fuel and one of over $7,000,000 for aviation lubricants, he said. This program is now nearly completed and the company's aviation fuel output is more than 12 times that of prewar days. The company leads the industry in the high proportion of aviation fuel made from the crude run.

The company's expenditures for development and research and engineering work are approximately $2,000,000 a year, to assure continued technological progress, said Mr. Pew. He referred to the recent development of Dynafuel, a new concentrate for aviation fuel, as a challenge to the future development of greatly improved engines and as opening a new field of technical development for both the engine designer and refinery engineer.

Raps 'Super-Planners'

Speaking at the same meeting, J. Howard Pew, president of Sun Oil Co., discussed the current proposals in Washington to draft all men in industry under a National Service Act.

"The super-planners are trying to jam this down our throats," he said. "Under this act a bureau would be set up in Washington, with hundreds of branches all over the country, and they would have the power to tell each and every man in this country how, when and where he must work. Such an act would deprive all of us of our freedom of choice, destroy our spirit and reduce us all to the status of slave labor. We want none of that. Under such a system production would surely fall to the level of that of those other countries which have slave labor. Fortunately, Congress has refused to pass such a law. And we must see that they never pass such a law."

The meeting of Sun Oil Co. workers was the climax of an inspection trip to the Toledo refinery by company officials from Philadelphia. The meeting was sponsored by the Independent Refinery Workers Union, the Office Employees' Assn., the Sales-Marketing Employees Assn., the Bay Terminal Railroad Union and the Supervisor's Union.

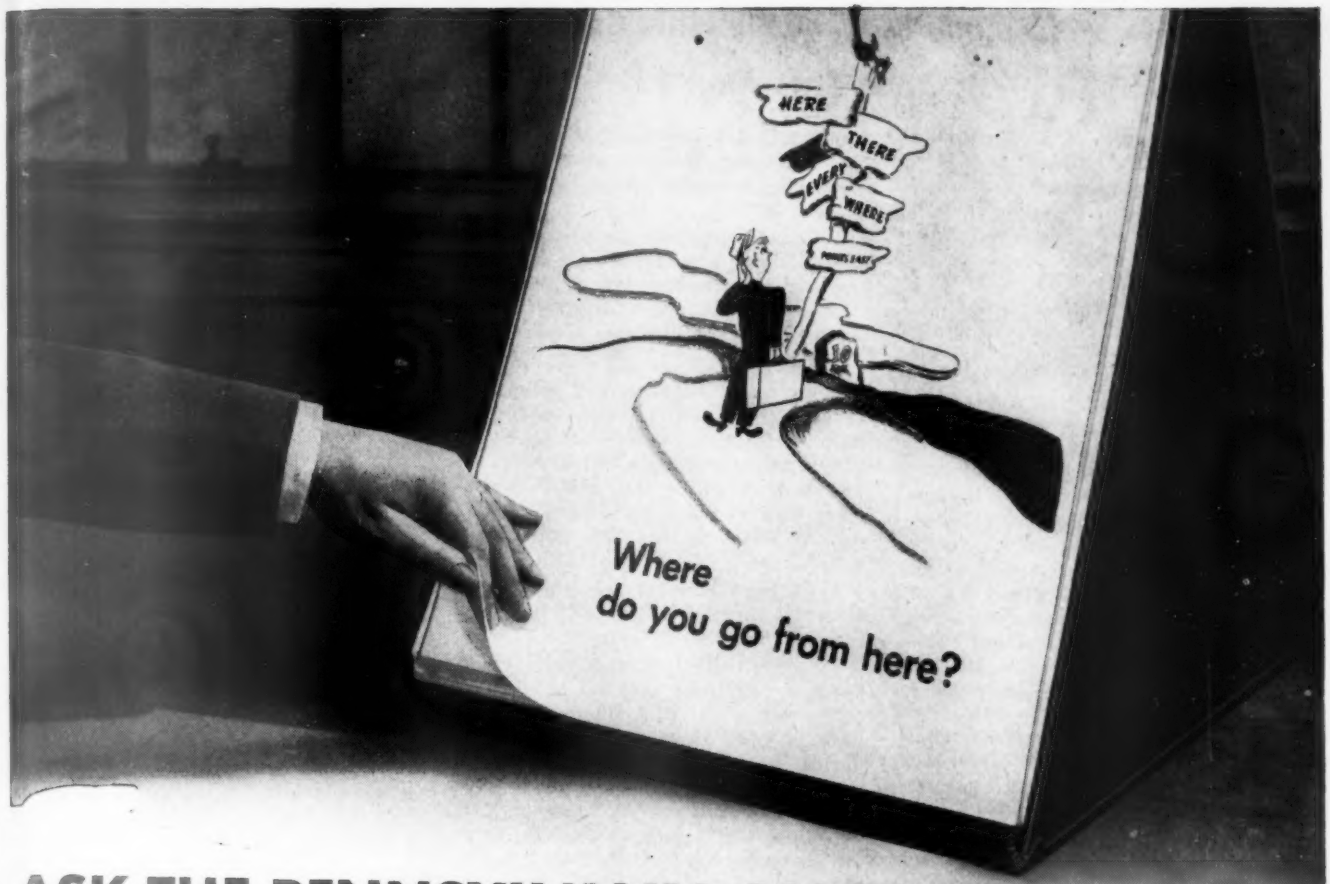
Shell Plans Farm Laboratory To Test Out Oil Products

Special to NPN

SAN FRANCISCO — Announcement has been made by Shell Oil Co. here of the establishment of a half-million dollar, 142-acre agricultural laboratory near Modesto, Calif.

Shell Oil Co. in cooperation with Shell Development Co. and Shell Chemical division of Shell Union Oil Corp. are co-backers of this latest Shell project.

This laboratory, the first of its kind in the West, will be used for making experiments in the field of spray oils, fertilizers, insecticides, fungicides, soil and grain fumigants and plant hormones.



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to show you a Post-War Plan, tailor-made for You!

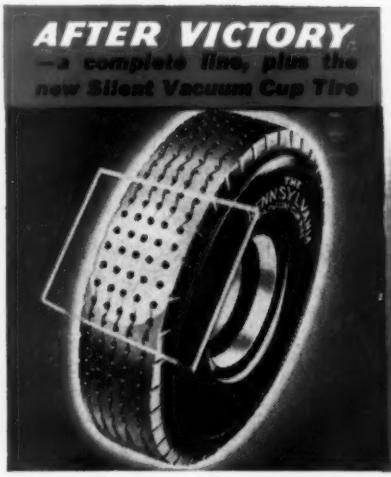
You will want to see the Pennsylvania 5-POINT PROGRAM for Profit. It is a practical post-war plan which will go to work for you right now—and help you sell the best customers in your locality now—and after Victory!

Your friend, the Pennsylvania salesman, will show you why it will be profitable to you to hang the Pennsylvania sign outside your place of business now and tell the world that you are headquarters for the top-quality passenger car and truck tires advertised in LIFE, THE SATURDAY EVENING POST, COLLIER'S, and a long list of other national publications. Your Pennsylvania salesman can supply you with recapping and repair materials, tire accessories and long-life Pennsylvania Batteries.

After Victory your post-war plan will shoot into high gear with the new Silent Vacuum Cup Tire—the greatest and safest tire ever built. Yes, sir, when you sign up with Pennsylvania you know the profitable answer to the question "Where do you go from here?"

PENNSYLVANIA TIRES

MANUFACTURED BY THE ORIGINATORS OF THE..... Silent Vacuum Cup Tire



PENNSYLVANIA RUBBER COMPANY

JEANNETTE, PENNSYLVANIA

Navy Offers 2,500,000 Bbls. of Elk Hills Crude For Public Sale; Will Open Bids Aug. 15

NPN News Bureau

WASHINGTON — Navy Department announced this week that it will offer some 2,500,000 bbls. of crude from Elk Hills Naval Reserve for public sale on Aug. 15 at San Francisco.

Representing estimated production for the six months' period ending next Dec. 31, crude will be the first obtained under the recent act authorizing a step-up in Elk Hills output to a maximum of 65,000 b/d. Crude is to be sold to highest qualified bidder, with all bidders having right to raise price after formal bids are opened and announced.

Purchasing refiners will be required to use crude for manufacture of various types of military products, "especially 100-octane grade, 130 aviation gasoline, navy fuel oil, special grade for the fleet and 80-octane all-purpose motor gasoline for the ground services."

Time for public sale is 10 a.m., P.W.T., Aug. 15, in the office of the district supply officer, Twelfth Naval District, Room 545, Federal Office Building, San Francisco.

Bidders Must Submit Statement

According to Navy announcement, each bidder will be required to submit in advance of the public sale an accompanying statement setting forth, among other things, the refining and other facilities owned, controlled or available for use in delivering the military products manufactured from Elk Hills crude; the availability of experienced operating personnel, and ability of refiner to utilize fully the facilities and personnel available in manufacture of military products.

All bids and accompanying statements must be submitted in triplicate and addressed to Secretary of the Navy, care District Supply Officer, Twelfth Naval District, at above address.

Following public sale, bids will be taken under advisement and acceptance or acceptances will be made within 30 days, subject, however, to later approval of the president, which may not be obtained within the 30-day period. Navy reserves right, "in the public interest," to reject all bids and order a new public sale.

Place of delivery of crude will be at U. S. Naval Fuel Annex, Elk Hills, adjacent to reserve.

Prospective bidders may obtain specifications containing detailed information on quantities of crude offered for sale, form of bids, bond requirements, payments, deliveries, volume measurements, provisions restricting price, gravity determination, form of contract, information to be supplied by bidder, etc., from the director, Naval Petroleum and Oil Shale Reserves, Navy Dept., Washington, D. C., or the inspector, Naval Petroleum Reserves in California, 402 U. S. Court House and Post Office Bldg., Los Angeles 12, or the district supply officer, Twelfth Naval District, Federal Office Building, San Francisco 2.

Texas Expert Rates Petroleum Alcohol Drinkable

NPN News Bureau

HOUSTON—The field of extracting chemicals from petroleum has barely been scratched, in the opinion of Dr. H. D. Wilde of Houston, member of the PAW's aviation gasoline advisory committee, and "there seem to be no limits to the future possibilities."

Dr. Wilde explained that, in general chemicals can be made from petroleum much cheaper than from any other resource and emphasized: "There is no basis for the claim sometimes made that chemical products made from petroleum are inferior to those from other sources."

Although he didn't recommend it, Dr. Wilde commented that the alcohol made from petroleum can even be used as a beverage "with no ill effects." Petroleum alcohol, he added, would not contain the impurities that provide the flavors characteristic of various beverages. Because of its high degree of purity, nearly all the ethyl alcohol produced synthetically has been used for industrial purposes."

Because of the relatively small amounts of petroleum necessary to produce chemicals, Dr. Wilde does not expect any drain on the present supply of crude to result from expanding chemical uses.

"The chemical industry expresses its production in terms of pounds or gallons per year, whereas crude production is expressed in terms of hundreds of thousands of barrels daily. One hundred million pounds per year is an exceedingly high rate of production for a chemical product, but 100 million pounds per year is only about 900 barrels of crude daily."

Cites Butadiene Figures

To prove his point, Dr. Wilde noted that a few years ago the production of 460,000 tons per year of butadiene from petroleum would have seemed fantastic, yet this quantity is only about 12,000 barrels daily. "Compared with the current crude production of over 4,000,000 barrels daily, the butadiene is almost negligible."

He stated that the tremendous demand from the war effort had brought about synthetic chemical production figures that would have seemed unbelievable in the pre-war days, notably the 100-octane gasoline program and the synthetic rubber and explosive program. Most of the refineries and chemical plants involved in the program are in Texas, he said.

He made these predictions as to the post-war scene:

The 100-octane gasoline plants now in operation will be kept for manufacture of aviation and motor gasoline of continuously improving quality. The toluene and xylene plants that are not converted to other uses will be used to produce aromatics to serve as raw materials for other chemical products.

"It appears quite likely that large volumes will be required for the manufacture of plastics, which is expected to expand tremendously in the post-war period," Dr. Wilde believes. "The synthetic rubber plants that remain in operation will continue to make the same or similar products."

Synthetic Rubber Production Must Continue After War

Special to NPN

DALLAS—The United States will need all the present capacity it has for synthetic rubber, in addition to natural rubber imports, for at least two years after the war ends, in the belief of Dr. H. F. Palmer, manager of the chemical division of the Firestone Tire and Rubber Co. in Akron.

Here to attend the meeting of the Southwestern Institute for Commercial Executives, the former production manager of the synthetic rubber plants of the Rubber Reserve Co. spoke before a civic club luncheon.

"Synthetics will have an opportunity to become competitive in cost and quality with natural rubber," he said. "It has been indicated that this country will need all the projected synthetic rubber production, as well as all possible natural rubber imports, for at least two years after the war in the Far East is over."

He told his audience that at the present time there are 18 synthetic plants, 18 butadiene plants, five styrene, and fifteen others. The Rubber Reserve Company, he said, administers approximately 250 contracts for the rubber program.

Grants CIO Oil Workers Union Voluntary Check-Off Right

NPN News Bureau

CLEVELAND—The Fifth Regional War Labor Board here on July 28, among other decisions, granted the Oil Workers International Union, C.I.O., voluntary maintenance of membership and check-off of union dues, affecting 112 employes of the Elk Refining Co., Charleston, W. Va. This was in lieu of the union's request for union shop, with industry dissenting.

In addition wage increases of 5 cents an hour were granted to all employes to preserve intra-plant relationships, as well as seniority in vacancies, promotions and the like when ability of the workers is found to be equal.

Denied by the board was the union's request for a night shift differential of 7½c an hour. This was on the ground that shifts are on a rotating basis, and factor of inconvenience is reflected in new wage increase, and in comparison with other oil refineries in the area.

The union had requested a 10c per hour increase retroactive to Dec. 6, 1943.

Auto Graveyards Are Taking in Jalopies at Around Quarter of 1942 Rate—Conservers Make Good

NPN News Bureau

CLEVELAND—Petroleum's role in the home front automotive transportation picture is reflected in today's automobile graveyard casualty list, which has dropped since 1942-43 from 5,500 daily to the present rate, now running at around 1,500 a day.

The industry's concerted campaign for preventive maintenance, which included every known form of publicity to make the country's stock of motor equipment last by conservation, can be credited to a large extent as the reason 4000 fewer cars per day are going to auto graveyards than in the 1942-43 period.

Less driving because of rationing and other restrictions plays only a part in the story. A completely changed driving program put an added burden on performance, due to "non-running-deterioration" greater than in pre-war operations. Only a campaign such as has been brought to the public by oil companies, large and small, could have resulted in such a remarkable showing as has been chalked up.

To get the facts, NPN has made a study of the auto graveyard section of WPB's industrial salvage branch. That branch of WPB, because that is its business, undoubtedly has the most accurate figures as to the number of cars going off the road.

The graveyard section's figures are based on reports of "actual purchases" of cars by auto wreckers in each WPB region. All but the very smallest are covered, and they cover better than 12,500 yards. Here are the figures:

No. of cars purchased	Year
2,043,000	1942
883,896	1943
52,220	January, 1944
41,736	February, 1944
40,526	March, 1944
39,595	April, 1944
41,059	May, 1944

Total, first five months of 1944, 215,136, or 1,415 per day.

WPB in commenting on the number of cars purchased in 1942 asserts that this figure is normal, as cars were junked pretty rapidly back in those days. The total, however, is made up of an estimate for the first four months of that year, as WPB was not set up and operating in that division during that period. All figures from May 1, 1942 are actual.

In addition to passenger cars, the figures include trucks purchased for junk, but this estimate amounts to only 2 to 3% of the total, WPB says.

Increase in the number of cars purchased in May, 1944, over April of that year is a normal seasonal trend, according to WPB. The tendency at that time, when engines overheat as the weather gets warmer is for the owners to give up the ghost and let them slide.

In analyzing these figures, it should be remembered that many cars are being purchased by taxicab outfits and other fleet operators, who strip them for parts to keep their fleets going. This operation, known in the trade as "cannibalizing," for obvious reasons, is a practice that is indulged in also by auto dealers.

In addition, there are thousands of unrecorded cars retired by their owners who simply drive them out in the lot or some place, and leave them there. These are little more than junk, though they never reach the wreckers.

In a recent release by the Federal Works Agency, registration statistics were cited showing that nearly 4,000,000 motor vehicles went out of use in 1942 and 1943. These figures take no account of any cars that may have been stored for the duration. That is an average of about 5,500 per day. Taking these figures as a basis for comparison with the 1944 figures, conservation and preventive maintenance may be credited with reducing the country's car casualty lists by about 4,000 per day.

West Tex-California Pipeline Blocked, Warns: 'Public Pays'

Special to NPN

DALLAS—The public will have to "pay the freight" under PAW Director Ickes' plan to ship from 30,000 to 40,000 barrels daily of West Texas sour crude from West Texas to California, the proponents of a pipeline from Texas to California charged after reading Ickes statement.

L. M. Glasco, secretary-treasurer of the Pacific War Emergency Pipelines, Inc., reaffirmed his statement that a pipeline capable of moving 175,000 barrels daily to the West Coast from Texas could be laid in four months. The company for a good many months has been trying to get priorities for materials to build the line, but without success.

"Ickes is beginning to realize that oil for a war effort powerful enough to smash the Japs may be another case of too little, too late," he asserted.

"Oil hauled by freight cars will cost a great deal more than oil sent by pipeline—and the public will be paying the freight."

The line which Mr. Glasco's company has proposed would extend from Monahans, Calif., to Beaumont, Calif., a distance of 980 miles. West Texas oil until recent months has been a drug on the market because of lack of transportation, although two new lines recently put into operation have eased this situation. The Texas Railroad Commission has affirmed, however, that there is plenty of excess oil available in the area to supply the proposed pipeline.

Fruehauf Trailer Launches New Branch in Texas

Special to NPN

DETROIT—Announcement has been made by Fruehauf Trailer Co. of the opening of a new factory branch in El Paso, Tex. This branch, one of the largest in that section of the country, will be equipped to maintain and repair all makes of trailers, the announcement says.

Rail Hauls To District 1 Decline 8,318 b/d

WASHINGTON—Tank car shipments to Dist. 1 averaged 718,052 b/d during week ended July 22, compared with 726,370 b/d previous week. Loadings reported by companies follow:

Aetna	29	Elk Refining	65	Rock Island	7
Allied	48	Eldorado	10	Roosevelt Oil	11
American Bitumuls	5	Freedom Oil	2	Root	59
American Minerals	173	Globe	188	Royal Petroleum	46
Arkansas Fuel	6	Gulf	2062	Shell	607
Ashland Refining	140	Hartol	122	Sinclair	506
Asiatic Petroleum	47	Hutex	5	Socony-Vacuum	2508
Atlantic Refining	1554	Industrial	6	Southland	9
Aurora	28	Jenny Mfg. Co.	73	S. O. California	15
James B. Berry Sons	3	Johnson	10	S. O. Indiana	876
Cantelou	15	Libby	1	S. O. Kentucky	57
Canton	10	Naph-Sol	7	S. O. New Jersey	5283
Chalmette	16	National Refining	16	S. O. Ohio	167
Cities Service (Pa.)	219	Ohio Oil	64	Sun	2311
Cities Service Refining	246	Pacific	100	Talco	35
Continental	272	Pan American	1453	Taylor Refg.	49
Cooperative Refining	27	Pana	4	Texaco	2240
Crown Central	9	Phillips	189	Tide Water	892
Daugherty	46	Premier	14	Tiona	5
Deep Rock	37	Primrose	26	Triangle	7
Derby Oil	26	Pure	128	United	6
Drake	3	Republic	5	White Fuel	1
Eastern States	10	Richfield	91	Worth	8

Abolition of Impeding Motor Transport Barriers Has Place on Postwar Transportation Program

NPN News Bureau

CLEVELAND — Artificial and unnecessary barriers which impede efficient and safe use of motor transport, or which increase the cost of producing efficient and safe vehicles is high on the agenda of the post war transportation programs, the Automobile Manufacturers Assn. has announced.

Immediate establishment by this association of a Field Service Department, headed by Karl M. Richards, was announced as a means of implementing the industry's cooperation with highway users and highway officials.

George Romney, general manager of the Automobile Manufacturers Assn., in commenting on the new field services, pointed out that in the field of use, we have costly state highway barriers. In the case of manufacturers, he said that because of costly state laws and regulations, it is impossible to make and sell the same type of vehicle in all parts of the United States. This is one of the problems demanding solutions in the interest of the nation as a whole, he said. Post war highway systems should be visualized on a basis of greatly increased use of motor cars and trucks, Mr. Romney asserted. This, he said, will call for engineering of the nation's highway system to meet these needs, including city streets and parking facilities to handle America's business and recreational travel.

It is the purpose of this new field service department to cooperate with national, state and local organizations and public officials in the highway transportation field to assist them where possible in carrying out highway transportation programs that will serve the interests of the nation as a whole, the announcement of the establishment of this department states. Operating with technically trained men in cooperation with the AMA Engineering Liaison Committee, the department will also cooperate with officials interested in maintaining and increasing the safety and efficiency of motor vehicles.

Further activities already under way designed to give vigorous support to post war highway transportation programs and recreate millions of useful jobs in the motor transport field, includes the formation of the highway policy committee. This committee formed by the board of directors under the chairmanship of Albert Bradley, executive vice president of General Motors Corp., to study highway construction and highway finance problems affecting the interest of motorists and other highway users include: A. Edward Barit, president of the Hudson Motor Co.; Robert F. Black, president of the White Motor Co.; Paul G. Hoffman, president of The Studebaker Corp.; B. E. Hutchinson, chairman of the Finance Committee, Chrysler Corp., and P. V. Moulder, Truck Division, International Harvester Co.

The Field Relations Committee consisting of C. J. Jolly, chairman, General Motors Corp.; R. P. Fohey, Chrysler Corp.; D. C. Fenner, vice president, Mack Manufacturing Corp.; Milton Tibbetts, vice president, Packard Motor Car Co.; Forest Siefkin, International Harvester Co.; W. H. Brearley, The Autocar Co., and H. J. Mellum of Nash-Kelvinator Corp., will continue to serve the industry in furnishing information on problems that arise in the field.

Major Jerry Sadler Decorated By Soviet Union at Teheran

Special to NPN

AUSTIN—A couple of years ago, if someone had said that drawling, snuff-dipping Texas Railroad Commissioner Jerry Sadler would be decorated by the U.S.S.R., Mr. Sadler himself would probably have been the most surprised person present.

Yet Maj. Gerald A. Sadler now wears the Order of the Fatherland, II class, and the U.S. Army has sent pictures back to prove it. (See cut)

Maj. Sadler, who used to be one of the three men in Texas who had broad powers over the Texas oil industry, is now a battalion commander, stationed in Teheran.

Boiled down, it means he is straw boss and "gang pusher" for a battalion of sweating labor troops who are loading and unloading the steady stream of supplies from the U. S. to Russia.

According to the U. S. Army the Order of the Fatherland is one of the highest Soviet decorations, and was presented to Maj. Sadler "for his leadership and tireless devotion to duty which enabled him to train a military unit unfamiliar with stevedoring operations to such a degree of efficiency that it is now the outstanding organization of its type in this command and an inspiration to all other familiar units who are striving to equal its records."

The award was presented by Decree of the Presidium of the Supreme Council of the U.S.S.R. on April 14, 1944. Lt. Gen. Milovsky sent the following communication in reference to the award: "My sincere and hearty congratulations . . . for the successful performance of the operations involved in the transportation of armament, equipment and food supplies to the Soviet Union, thus affording great assistance to the Red Army in the struggle with the Nazi German invaders."

Presentation of the award was made by Richard Ford, Charge d'Affaires of the American Legation at Teheran, Iran.

Former Texas Railroad Commissioner Jerry Sadler, now a major in the U. S. Army in Iran, is shown receiving the Order of the Fatherland, II Class, from Richard Ford, Charge d'Affaires of the American Legation at Teheran

Big Fleet of Towboats Soon Will Ply Mississippi System

NPN News Bureau

CLEVELAND—ODT's towboat and barge-building program is in its final stages, Ernest Holzborn, ODT assistant director in charge of water transport, announced on July 24. The program started a little more than a year ago.

Twenty of the 21 towboats contracted for, Mr. Holzborn said, are actively engaged in towing barges of vital wartime freight on the Mississippi system, and the last of the 21 is due for delivery within thirty days.

All of the final group of 155 steel cargo barges have been delivered, the announcement says. 100 of these will be used for carrying oil, 55 for transporting dry cargo.

"These boats and barges are of the type adapted for work on the Mississippi and its tributaries and are giving an excellent account of themselves in transporting needed commodities," Mr. Holzborn said. "The towboats differ from deepwater tugboats in that they are designed to get behind great convoys of barges, lashed securely together into a compact unit, and push them up or downstream. The oil barges have a capacity of 9000 barrels each, the dry cargo barges are of 1500-ton capacity. As many as ten or 12 barges make an average tow which one towboat can push."

Most of the boats, all of which have been chartered to privately operated transportation companies, were built at boatyards on the Ohio and Mississippi Rivers and at Great Lakes ports. Some came from plants in Texas through the Gulf Intercoastal Waterway. Those built at Great Lakes ports were brought out via Chicago and the Illinois Waterway into the rivers.

'24 to '44

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100% Pure Pennsylvania Motor Oils

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Because of its high quality, war demands great quantities of 100% Pure Pennsylvania Motor Oils and this demand comes first, of course. Our region is producing and refining to the limit. Our oils are still available most everywhere for essential motoring needs.

Optimum Rate Program Brings Big Boost To Arkansas Fields

NPN News Bureau

CLEVELAND—Added recovery in three Arkansas pools of oil exceeding 87 million barrels by reason of the Arkansas Oil and Gas Commission's system of optimum rate proration, is the bright picture reported by Alec M. Crowell, director, in his quarterly report to the Commission. Ultimate recovery in other fields, by reason of scientific curtailment, will result in ultimate recovery being increased by many million barrels, Mr. Crowell forecasts.

Reporting on the Midway pool, Mr. Crowell asserted that this was the only deep limestone pool in the world which is being repressured with fresh water. Fresh water is being injected from specially drilled water wells into the oil producing horizon at a depth of 6340 feet. During the first six months of this year 1¼ million barrels of oil were removed from the reservoir, and yet the reservoir pressure was increased by 29 pounds. He estimated that the ultimate recovery from the Midway pool of Lafayette County would be increased from 32 million barrels to 65 million barrels.

Forecast Bigger Savings

Relying only on scientific curtailment, Mr. Crowell reports, the Village Pool withdrew one quarter million barrels of oil from a depth of 7390 feet with a pressure increase of two pounds during the first six months of the year. The only source of pressure replenishment is the natural water drive. He estimated that the system of proration now in use, if continued, will result in ultimate recovery being increased from 4 million to 24 million barrels.

Pointing out that if the present plan to maintain pressure in the giant Magnolia field of Columbia is continued, as much added oil as all of the present pressure maintenance programs of the state represent should result. Production is found there at a depth of 7350 feet.

Phillips Leases Big Tract Near Columbia Oil Fields

BARTLESVILLE—Phillips Petroleum Co. has confirmed a report that it has leased from the Benedum-Trees interests and Leonard Oil Development Co. of Pittsburgh the Simiti lands comprising approximately one million acres lying in the Magdalena River Valley, Colombia, South America. This land is about 250 miles upstream from Barranquilla, Colombia, principal port on the Caribbean sea. The tract lies approximately midway between the Barco concession in eastern Colombia and Los Infantas field in Central Colombia.

This latter field contains 1200 oil wells and 49 dry holes and has produced 312,000,000 bbl. of oil through 1942. The 10-in. pipeline serving this field runs along the eastern edge of Simiti lands. It is now carrying 57,000 b/d. Phillips officials stated that as soon as necessary formalities had been completed with the Colombia government the company would proceed with geological and geophysical work preparatory to drilling test wells.

Continental Well Raises Hopes For New Pool Near Bowie

PONCA CITY, Okla.—Development of a new oil pool in Texas was in prospect with announcement by Continental Oil Co. of the discovery of another wildcat oil well, the Hundley No. 1, about 10 miles east of Bowie, and one mile southwest of Mallard, Montague county.

The Hundley No. 1 produced 275 bbl. of 40-gravity oil in five hours, on a ¾-inch choke. Drilled to 8018 ft., the well was perforated and is producing in the conglomerate at 6228-6235 ft.

This well is located five miles east of the Mueller pool, and two miles northeast of another wildcat producer which came in about a month ago.

The Hundley is a Continental-Sinclair partnership well, located on a joint-ownership block of 1310 acres. In addition Continental owns a block of 284 acres.

Find Oil in Smackover Lime; Believed First in Texas

TEXARKANA, Tex.—An oil strike in the Smackover lime, believed by operators to be the first from this formation in Texas, has been hit in the Texarkana area.

Regarded as highly significant by the operators, the Barnsdall and Sohio Oil Co.'s Heilbron No. 2 came in on July 23 and flowed at the rate of 600 barrels daily on a drill stem test.

K. W. Haley, production superintendent for Barnsdall, said the gravity of the oil was 38 and the gas-oil ratio was 1200 cubic feet of gas per barrel of oil.

Total depth of the well is 7716 feet.

Blasts U. S. Retention Of Mineral Rights In Farm-Tenant Law

Special to NPN

TYLER, Texas—Voicing the apprehension that Texas oil circles have been feeling for some time, the East Texas Oil Assn. has issued a blast at the federal government's practice of retaining three-fourths of the mineral rights on all land foreclosed under the Bankhead-Jones Farm Tenant Act.

Uncle Sam is acting selfishly in taking advantage of unfortunate farmers, and at the same time is getting into the oil business in a big way, a release from the Association charges.

The statement alleged that three federal agencies in Texas now control the mineral rights on more than a million acres of land. The statement says that I. W. Guggan, acting governor of the U. S. Department of Agriculture, has admitted that the Federal Loan Bank in Houston is now holding "mineral reservations" on 4039 tracts totaling 786,929 acres; the Federal Farm Mortgage Corp. "held mineral reservations on 144,545 acres involving 650 separate tracts of land"; and that according to Administrator Frank Hancock, the Farm Security Administration has acquired 103,750 acres of land and at least 75% of the minerals have been retained on all land sold.

Holdings Over Million Acres

These three holdings represent over a million acres, in addition to 652,354 acres held by the Forest Service and 106,883 by the Soil Conservation Service.

"Congress and state legislative bodies should immediately erect a stringent law which would prevent individuals, insurance companies, banks and all federal agencies from benefiting by and through the misfortunes of farmers and ranchers, the association said. "Certainly it cannot be maintained that land from which all, or three-fourths of the minerals have been detached, is as valuable as a mortgage carrying all the minerals. Minerals acquired under any conditions of foreclosure should follow the land."

The statement commented that "farmers are wondering if their representatives in Congress were asleep July 22, 1937, when the Bankhead-Jones Farm Tenant Law was enacted."

OPA Boosts Ceiling on Barite; Used Chiefly in Oil Drilling

NPN News Bureau

WASHINGTON—A new ceiling on barite, effective July 31, has been announced by OPA. The maximum price for barite produced in Missouri was set at $8.50 per short ton (for crude ore containing approximately 94% barium sulphate). This maximum price, OPA states, is to "assure its continued production." Former maximum prices generally ranged from $7 to $7.25 per short ton.

Barite's largest single use is in the

production field in connection with drilling. OPA in recognizing the critical importance of the product to both the military and civilian economies, said that according to WPB, the supply at present is insufficient to meet estimated requirements for essential uses.

OPA said that information obtained in a recent survey on barite producers in Missouri, indicated that production costs had so increased that, with recent wage increases authorized by the National War Labor Board, a large part of Missouri production would be at costs in excess of the present maximum prices. The financial condition of the industry, OPA said is such that it appears to be necessary to increase the maximum price of Missouri barite to assure essential production.

The order is in the form of amendment No. 6 to Maximum Price Regulation No. 327—Certain Nonmetallic Minerals.

Pipeline Approved for First Devonian Pool in Texas

MIDLAND, Tex.—The first Devonian formation pool ever opened in Texas will have a pipeline outlet for its oil.

The Texas-New Mexico Pipeline Co. has received approval from PAW for laying three miles of four-in. pipe from the Texas Co.'s No. 1 Hobbs in extreme Southeastern Crane County to the pipeline company's McCamey station in southwestern Upton county.

The Devonian discovery is still being tested after showing approximately 250 barrels of oil daily through 200 perforation shots from 5300 feet to 5350 feet early in May. It has also been perforated with 168 shots from 5365 feet to 5390 feet in order to test the lower part of the pay section.

Louisiana Output Increased Grant 3 Exceptions to Rule 37

BATON ROUGE, La.—Louisiana oil wells in August are producing 393,117 barrels daily, a slight increase over the 389,224-barrel allowable in July.

The Minerals Division of the State Conservation Department set the following allowable by districts: Houma 62,895; LaFayette 107,597; Lake Charles 67,947; New Orleans 78,066; Monroe 33,159; and Shreveport 43,453.

Tensleep Crude Gets Boost

TULSA—Sinclair Wyoming Oil Co. has announced a flat posting of $1 per bbl. for Tensleep crude from Lost Soldier Field, Wyoming, retroactive to April 26. Tensleep crude formerly was bought on a gravity basis posting of below 29 at 76c with 2c differential per degree to top of $1 for 40 gravity and above. The flat posting in effect represents an 8 to 10c per bbl. price increase, a company spokesman said.

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Don't Confuse LUBRI-GAS with fuel-treating "dopes" BECAUSE:

1. LUBRI-GAS has been manufactured since 1917.

2. LUBRI-GAS treated fuel is a Premium Quality fuel, and therefore is logically governed by OPA Regulations applying to premium fuel.

3. LUBRI-GAS' record is absolutely clear. It was NOT included in the recent criticisms of 150 motor fuel "dopes" according to a letter from the National Bureau of Standards.

4. LUBRI-GAS is NOT a motor fuel "dope". There is nothing else like it.

5. LUBRI-GAS actually CLEANS and LUBRICATES your motor.

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LUBRI-GAS is essentially a 40 SAE Lubricating Oil. It is processed with a detergent and other chemicals so that the treated oil mixes freely with the motor fuel.

WHAT LUBRI-GAS DOES—

LUBRI-GAS enters the combustion chamber in the form of a fine, oily mist, or fog. This fog will not burn at motor temperatures. Instead, it condenses back to clean oil.

LUBRI-GAS then forms a perfect film over valves, spark plugs, cylinder walls, pistons and piston rings.

Carbon, gum and sludge will not stick to a cleanly-lubricated surface, so are discharged through the exhaust. Thus, sticky valves are freed, knocks disappear and the motor has more power and better performance.

By cleaning and oiling upper cylinder parts, there is no drag, heat or wear from metal rubbing on metal. Friction is decreased. Compression is increased. Overheating is prevented.

LUBRI-GAS RESULTS—

LUBRI-GAS immediately results in a remarkable increase in motor power and pep. Users get more miles per gallon of fuel.

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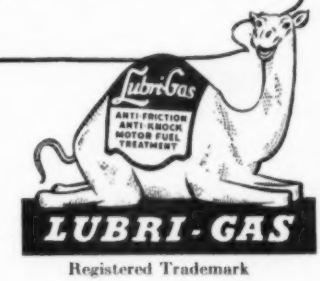


Registered Trademark

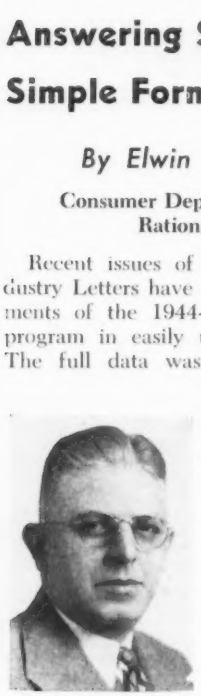
Answering Some Questions on Fuel Oil Rationing; Simple Form Devised for Consumer's Receipt

By Elwin E. Hadlick

Elwin E. Hadlick, executive head of the Northwest Petroleum Assn. and prominent Minneapolis lawyer, discusses three problems which crop up frequently in connection with fuel oil rationing, in the accompanying article. It is the 20th in the series on compliance with war-oil regulations.

Consumer Deposit of Fuel Oil Ration Sheets

Recent issues of OPA's Fuel Oil Industry Letters have set forth the requirements of the 1944-1945 fuel oil ration program in easily understood language. The full data was consolidated, along with appropriate comments, in a special article in the June 28 issue of NPN.



Mr. Hadlick

Industry Letter No. 34 set forth in detail the requirements for the receipt which oil companies must give to consumers when the latter deposit their fuel oil ration sheets with the companies. These requirements were spelled out in such fashion that the preparation of a receipt form was a reasonably simple matter. Most companies who plan to accept coupon sheets or who are already accepting them have worked out their own form of receipt; some of these are long, some are short, and all that we have seen seem to be adequate. There have been a number of inquiries, particularly from small jobbers, asking for an appropriate form.

The best form we have seen from a standpoint of simplicity and completeness combined is one made up and printed on the back of a government stamped postcard. This card with the name and address of the consumer on one side and the other data on the other contains all the essential information. A copy is reproduced in this issue for the convenient use of those who have not already developed their own form. (*See p.* 41)

One company, not operating on the keep-fill or automatic delivery system, has made additional use of the postcard form of notice by adding a line "deliveries will be made only on order."

Consumer Signatures on Deposited Fuel Oil Ration Sheets

One can read the Fuel Oil Industry Letters issued in connection with the 1944-45 fuel oil rationing season from end to end and not in any fashion become aware of any responsibility on the part of an oil company to see to it that the consumer signs the sheet and indicates the date he received it, before depositing with the oil company. Everyone realizes that near the bottom of the center of a fuel oil ration sheet there is a line reading "persons to whom this sheet is issued must sign and enter date below", and that following those words there is a place for a date and for the consumers signature.

Many oil companies, if they have considered the matter at all, have assumed that the obligation of signing was something between the consumer and the OPA; they have not considered that the oil company had any police responsibility to see to it that the consumer affixed his signature before depositing. Such companies were rudely awakened a short time ago by a bulletin from OPA wherein attention was called to the necessity of signing of coupon sheets by consumers before depositing, and pointing out that any sheets accepted without signatures were improperly received. Oil companies with coupon sheets on hand without signatures hurriedly re-examined the industry letters and found not a single word concerning the matter.

Protests have been filed with OPA. Request has been made that either the signing be waived, or that an announcement be made that any coupon sheets accepted by oil companies without signature prior to the date of the announcement be considered properly accepted.

Suggesting a Solution

Whatever the objections, the chances of OPA changing its mind are very slight. This same problem came up in some markets last year, although in most markets oil companies were not aware of any responsibilities for consumer signatures, and probably operated all last year contrary to something that OPA considers quite essential.

There is a practical problem involved for an oil company which has accepted unsigned sheets from consumers. The oil company does not have the gasoline to permit its employes to drive passenger cars around to secure consumer signatures; certainly ODT regulations will be violated if trucks are sent out for the purpose. The mailing of coupon sheets back to the consumer seems fraught with danger because the consumer would then have in his possession both the coupon sheet and the oil company's receipt therefor; where would the oil company come out if the consumer asserted he did not receive the coupon sheet which the oil company said it had returned?

The solution to the practical problem is quite simple; at least it was so last year. Oil companies who learned of the rule last year after accepting unsigned coupon sheets sought and secured authority from District OPA offices to handle the entire matter by mail. They were permitted to secure a written authorization from the consumer to permit an oil company employe to affix the consumer's signature. Undoubtedly the permission of the District Director of OPA can be secured for an oil company acting on a written authorization from the consumer in a form which was approved for use by a substantial oil company last season. This form was—

Date .....

Name and Address
of Company

Gentlemen:

I herewith give permission to your Fuel Oil Rationing Expert in charge of my coupons on deposit with you, to act as my Agent for the purpose of properly dating, ar affixing my signature, where lacking on my coupon sheet Serial No. .....

I received said coupon sheet from my local board on .....194...

This is done with your assurance such is authorized by OPA and in order that my coupon sheet will show that I am in compliance with OPA regulations.

Signed .....
Address .....

Consumer Advisory Service for Fuel Oil Rationing

There appears to be confusion in some parts of the industry in connection with two suggested plans for consumer advisory service for fuel oil rationing as set forth by OPA in Fuel Oil Industry Letter No. 34. In that bulletin the OPA set forth two plans for delivery control systems that would readily divulge to the system operator a customer's ration position. One of these systems was for concerns operating on an automatic delivery basis, the other for concerns using the non-automatic system.

A number of small companies have raised the point that it is impossible for them to install either of the elaborate systems suggested because of the cost factor. They are concerned as to what they fear to be a violation of the rationing regulations. They need have no fears. A re-reading of the Industry Letter 34

will indicate clearly that neither system is compulsory; no oil company is obligated to adopt all or any part of the plan.

The suggested systems were prepared by well qualified men and they represent probably the finest work that has been done in the field of consumer fuel use control. The nature of their origin should be remembered by the oil industry and particularly by any oil company which could adopt one or the other of the systems by a not too great expenditure of additional energy. They are the outgrowth of a very strong promotion this last spring to prohibit the depositing of consumer coupons with oil companies. The depositing or non-depositing of coupons matters little one way or the other in smaller communities. In the larger cities there are innumerable reasons why oil companies could not successfully operate their businesses if coupons were not deposited in advance. The oil industry came very close to losing the depositing privileges this year. A broadminded and sympathetic approach by OPA officials is largely responsible for the fact that the privilege still exists. Those OPA officials permitted continuation of the system as an absolute necessity for the oil industry even though they were convinced that the widespread practice of coupon sheet deposit with dealers was a contributing cause to over-consumption.

No oil company is required to adopt either of the suggested plans of consumer notification and delivery control. All indications are that any company which could operate one of the systems or a reasonable facsimile thereof would do well to put it into effect. Those systems represent the thinking of responsible oil men and of OPA officials as to the responsibility which should be assumed by oil companies who accept deposit of consumers fuel oil ration sheets.

Ration Coupon Sheet Acknowledgment

This will acknowledge receipt of your coupon rationing sheet which totals .....gallons based on ten gallons per unit. Serial No. ..... Class..... with the following coupons attached:

PERIOD 1 Units	PERIOD 2 Units	PERIOD 3 Units	PERIOD 4 Units	PERIOD 5 Units	Change and Inventory Coupons
No.....	No.....	No.....	No.....	No.....	.....Gal.

Last season's valid coupons on hand .....gallons.

We will retain this sheet and as your orders are received by us we will detach the proper amount of coupons. We suggest that you keep this receipt and use it as a guide in keeping track of the amount of oil that has been allocated to you under your ration.

..... Company

Date..... By .....

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(Issued July 22-29, 1944)

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PAW Wire to Dist. 2 Refiners—Increase in production of distillates

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CODE: AO—Administrative Order; CMP—Controlled Materials Plan; D—Directive; FDO—Food Distribution Order; GMPR—General Maximum Price Regulation; GO—General Order; Interp.—Interpretation; L—Limitation Order; M—Conservation Order; MPR—Maximum Price Regulation; P—Preference Rating Order; PAO—Petroleum Administrative Order; Pri. Reg.—Priorities Regulation; Proc. Reg.—Procedural Regulation; PS—Price Schedule; RO—Ration Order; RPS—Revised Price Schedule; SO—Supplementary Order; SR—Supplementary Regulation.

Digest of Week's War-Oil Orders

Petroleum Administration for War

TRANSFER AND CONVERSION OF FUEL OIL—PDO 13, as am. 7-25-44—PDO 13 amended to conform to new provisions in Rev. RO 11 (Am 17—see 7-26 NPN, P. 41). PAW will continue to make final determination as to installation of new oil burning equipment in any structure, and will process requests for authority to reconvert equipment to use of fuel oil in buildings housing 4 or more families and those where over 10,000 gals. are consumed per year. PAW will handle all applications for use of fuel oil in new and reinstalled facilities for agricultural, commercial, and industrial processing, but appeals will be granted only on basis of unreasonable hardship in converting. Issued 7-25, effective 7-29.

PREMIUM MOTOR FUEL MANUFACTURE IN FAR WEST—PDO 21, Am. 1—Base period and permitted percentage cut. See story p. 30, 7-26 NPN.

RESTRICTIONS ON TRANSFERS AND USE OF AVIATION-GRADE BASE STOCK, BLENDING AGENTS, AND HIGH-OCTANE AVIATION FUEL—Petroleum Directive 77—*See* text given on p. 27, 7-26 NPN.

CRITICAL PETROLEUM PRODUCTS — PAW Release re Preferential Groups Petroleum Products — Petroleum coke only petroleum product removed from critical list. In first preference and critical group are components of aviation gasoline, butadiene, and petroleum synthetics; second group, aviation gasoline of 87 ON (as designated by PAW) and 90 ON, 80 ON all-purpose gasoline, 73 ON aviation gasoline (as designated); select gas oil charging stock for units producing aviation gasoline, special naphtha charging stock for hydroformer charge, microcrystalline wax as specified by PAW; third group, 7-0-2 military Diesel, heavy naphtha charging stock for butadiene, aviation and heavy duty military lubricants, Diesel lubricants.

APPOINTMENT OF AREA MANPOWER REPRESENTATIVES—PAW Release—In cooperation with WMC's priority referral program, PAW Area representatives have been appointed to serve as advisers to WMC Manpower Priority Committees. Programs vary in each area, according to conditions prevailing there, but follow general overall pattern. Certificates of availability mandatory in all areas. Seven men represent Dist. 1; 1 man represents Dist. 2; 3 men represent Dist. 3; 2 represent Dist. 4, and 1 man Dist. 5. Issued 7-17.

INCREASE IN PRODUCTION OF DISTILLATES REQUESTED—PAW Wire to Dist. 2 Refiners—*See* story p. 30, 7-26 NPN.

EXCEPTIONS TO 70 OCTANE HOUSEBRAND GASOLINE DIRECTIVE—PAW Wire to District Refining Directors—Exceptions to degrading of housebrands from 72 to 70 octane to be granted only because of exceptional hardship. Suppliers who cannot decrease to 70 octane, because of cracking operations conducted primarily for manufacture of war products, are urged to blend with gasoline of another supplier who can produce gasoline of less than 70 octane. Issued 7-13.

EASTERN SUPPLIERS' POOLING ARRANGEMENTS — Recom. 5, Revocation — These arrangements already superseded by

Directive 59. Issued and effective 7-25.

DIRECTIVE 77 NOW CONTROLS MANUFACTURE OF AVIATION GASOLINE — Recom. 8, Revocation—Issued and effective 7-24.

UNBRANDED MARKETERS' REPORTS TO PAW—Recom. 10, Revocation—Directive 59 has for some time covered this matter. Issued and effective 7-25.

AVIATION GASOLINE—Recom. 16, Revocation—Directive 77 supersedes this recommendation. Issued and effective 7-24.

Office of Price Administration

FUEL OIL AND GASOLINE PRICE CHANGES—MPR 88, Am. 12—Specific fuel oil ceilings set for Lower Inland Texas and specific tank wagon prices for Washington area outside of District of Columbia. Gulf Coast Ports and New Orleans area ceilings for Diesel oil, ships' bunkers, modified, setting new price of $1.35 for distillate below 28° API gravity in single lot deliveries, with 10c bbl. added for deliveries under 50 bbls. Dixon, Ky. tank wagon price for premium gasoline is 11.5c, for regular grade 10c. Published quotations for gas oil at Gulf and for barge sales of gasoline at New York Harbor no longer apply. Issued 7-25, effective 7-31.

AFFIDAVITS DELETED FROM SERVICE PRICE REGULATION—RMPR 165, Am. 1—Applications for approval of adjustment of service prices need not be sworn to. Issued 7-27, effective 8-1.

CEILING FOR INDUSTRIAL SOLID PRESSED-ON TIRES—MPR 528, Order 8—Retail ceilings for Firestone 17 x 6 x 12-1/8 tire is $24.65 for East and $26.50 for West. Issued 7-28, effective 7-29.

TRACTOR IMPLEMENT AND TRUCK TIRE RATIONING—RO 1A, Am. 81—Any industrial-type tire or Grade I tire suitable for vehicle for which certificate was issued may be delivered in exchange for Grade I certificate, and any suitable-sized Grade III tire for a Grade III certificate. A dealer or manufacturer may transfer new tires to a vehicle manufacturer only upon receipt of certification required by Rubber Order R-1; may transfer used tires to such manufacturer upon certification that tires will be mounted on vehicles manufactured by him within 30 days of acquisition. Issued 7-29, effective 8-2.

REPLENISHMENT PORTIONS OF TIRE COUPONS—RO 1A, Am. 82—Form R-306 may be used for issuance of a tire certificate only after Regional Administrator, upon Deputy Administrator's approval, has so authorized Board or District Director. "Part B" is hereafter to be referred to as "replenishment portion", and must be voided upon issuance of a certificate for a used truck tire. Dealers discontinuing the tire business may transfer their replenishment portions to the person intending to sell tires at that location only upon written authorization of District Director, and replenishment portions must bear transferor's name and address, with date of transfer. Such authorizations may be granted upon joint application of transferor and transferee stating number of such portions transferred. Lacking such authorization a dealer who discontinues the tire business must surrender his replenishment portions to District Director, for cancellation and issuance of a receipt.

BANK OF DEPOSIT MAY NO LONGER OPEN ENVELOPES CONTAINING COUPONS—Gen. RO 7, Am. 10—Issued 7-28, effective 8-1.

War Production Board

TIRE PRIORITIES — Essentiality List of Truck and Bus Motor Vehicle Services—Crude petroleum trucks assigned priority rating of 1 (highest rating) in over-the-road commercial operations and wholesale local commercial delivery and service operations; petroleum, oils and greases same rating, with 2B rating for retail local commercial delivery operations. Motor fuel in tank trucks 1, 1, and 2B; fuel oil in tank trucks 1, 1, and 2B; gas in containers 2A, 2A, 2A rating. Issued 7-22.

GAS CYLINDERS NOW UNDER CONTROL OF M-293—M-233, Revocation—Issued 7-25.

CONTAINERS DIVISION TABLE—M-293, Table 17—Manufacture of all gas cylinders now under Table 17, designated as X product, and frozen for 2 months at a time. Frozen schedules or specific directions received under M-233 must be observed. Ratings for these cylinders may be assigned on Form WPB 541, 542, etc. No preference rating for MRO supplies may be used to obtain containers suitable for transportation of gas under pressure. Issued 7-25.

MATERIALS FOR LABORATORIES—P-43, as am. 7-22-44—P-43 ratings may be used to get MRO materials for structures needed to carry on scientific or technological investigation, testing, development, or experimentation, without getting permission under L-41; also to get materials for carrying on experimental construction jobs (when purpose is to test building, equipment, or fixture), but only to the extent permitted under L-41. Issued 7-22.

MRO RATINGS FOR PLANTS ENGAGED IN SEVERAL ACTIVITIES—CMP 5, Interp. 14—Plant may use at all times for MRO supplies the rating assigned to its principal activity, if this activity covers major part of the year. Issued 7-22.

CAPTIVE REPAIR SHOPS INCLUDED UNDER 9A—CMP 9A, Interp. 4—Issued 7-27.

DELEGATION OF AUTHORITY TO OPA IN RATIONING OF TIRES AND TUBES—Supp. Dir. 1-Q, as am. 7-22-44—OPA controls all transfers, use, alteration, and mounting of tires, casings, tubes, retreading and recapping materials, but not manufacture of tires and allied products; it may prohibit transfer of tires and gasoline to any violator of any OPA order. Issued 7-22, effective 7-25.

OIL-LAW-Gram Service

Complete texts of all orders or amendments digested in war-oil orders can be had from Platt's Oil-LAW-Gram, 1213 West 3rd street, Cleveland 13, Ohio. Minimum charge single copies $1. Copies of these texts are always in stock but large orders can be promptly filled by reprinting as plates and stencils are also kept.

Complete daily Oil-LAW-Gram service, with necessary binders, $100 per year in advance.

Due care and judgment have been taken in preparing and publishing these digests and in reproducing the original texts but the publisher does not warrant their absolute legal completeness nor accuracy. Important decisions by the reader should be made only after careful study of complete texts.

Interstate Commerce Commission

TRANSPORTATION RATES IN CENTRAL UNITED STATES ON LOW-GRADE PETROLEUM PRODUCTS—Fourth Section order No. 15152—Tank car loads of distillate and residual fuel oil, heating, furnace, burning, Diesel, tractor, road, coal-spraying, and gas oil, and asphalt from certain midwestern states to certain north-central states shall be transported at rates not exceeding 80% of gasoline tank-car rate, effective 60 days after the establishment of rates authorized by Order 15152, granting relief from long-and-short-haul provision of Sec. 4 of ICC Act. To continue for 5 months, except upon proper application for longer continuance. Issued 7-18.

MOTOR CARRIERS REQUIRED TO RETAIN RECORDS FOR ICC INSPECTION—Notice of ICC—All carriers and brokers subject to Part II of ICC Act must keep required records readily available, and unduly long retention of such records by auditors and accountants is forbidden, as well as failure to retain copies of working papers supporting accountant's journal entries covering adjustments, etc. Issued 7-18, effective 7-22.

National War Labor Board

DIRECTIVE ORDERS IN DISPUTE CASES —NWLB Rules of Procedure—Petition for review does not stay that part of a directive order continuing the terms of a prior contract which has expired or been terminated. Directive orders stand confirmed the day following the last day for filing a petition for review, though NWLB may prior to such time make an order immediately effective pending further proceedings. If only part of an order is sought to be reviewed, any party may petition NWLB to make remainder immediately effective. Issued 7-18.

WEEKLY SUMMER HALF-HOLIDAYS FOR SERVICE ESTABLISHMENTS—NWLB Resolution—Permitted without prior NWLB approval through 9-15-44, without reduction in compensation, if such practice is in accord with establishment's past custom, or is practice of similar establishments in local community. Issued 7-18.

INTRASTATE DISPUTE CASES—NWLB Resolution—While employer's engaging solely in intrastate commerce does not deprive Board of jurisdiction over employees' labor disputes, the Board will normally exercise its jurisdiction over such cases only when the union involved has demonstrated that it represents a substantial number of the employees concerned. NWLB will determine all issues concerning wage rates and other adjustments, such as vacations, incentive payments, etc. which are within national wage stabilization program. Other issues will be determined on their merits and may be referred back to parties with or without NWLB's retaining jurisdiction. Effect on war effort will govern in all cases. Issued 7-12.

Tags Station Operator for Alleged Coupon Lending

NPN News Bureau

DALLAS—The alleged lending of "T" coupons representing 1000 gallons to another filling station operator has Edwin R. Joyce, Dallas filling station man, in a jam with OPA.

The OPA, in filing an injunction proceeding against Joyce, alleged that he loaned the coupons to Harry St. Clair, and that when the coupons were paid back they were illegal coupons and not issued by any ration board.

St. Clair is facing a federal indictment charging possession of coupons stolen from ration boards.

In another gasoline case here, the OPA asked federal court to restrain J. H. Caldwell, service station operator, from extending ration credits to his customers. The OPA charges that he furnished gasoline to customers, agreeing that they could deliver the coupons at a later date.

Grant 3 Exceptions to Rule 37

AUSTIN—The Texas Railroad Commission has authorized exceptions to Rule 37 (spacing) on three oil leases in East Texas in order that the allowables can be transferred within the leases.

Affected are Magnolia's J. C. Bradberry and J. B. Wilson leases in Rush county, and the Texas Company's R. B. Walls lease in Gregg county.

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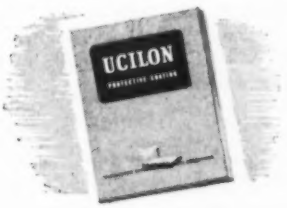

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Midwest Oil Companies Have Devised Methods Of Complying With Many Government Orders

NPN News Bureau

CHICAGO—Oil companies operating over the Midwest have worked out various systems for keeping track of the numerous government agency directives, orders, recommendations and other regulations so that compliance in a large measure has become a matter of habit.

Some difficulty is still experienced with new help, both in the offices and in the field where manpower continues a problem because of changes in bulk plant and service station employes or operators, but even that situation is not as difficult.

There is nearly always one or more trained workman in the organization to help the newcomers get started on the right foot, and avoid at least some of the confusion and delays that were common in the industry when rationing and other programs were started. Some examples of how the industry is endeavoring to comply with regulations are given below.

Pure Oil Co. have the distribution of all incoming regulations highly departmentalized and no longer feels the need of a centralized record and distribution center. The heads of all operating departments receive Platt's OIL-LAW-GRAM and check them daily for new orders and regulations or revisions of old ones. Most regulations are now a continuation of old orders by revisions or amendments.

Rarely a Centralized Study

Only when something entirely new comes out is there a centralized study of the situation. For example, the stripper well subsidy, which higher officials of the company are now examining for its effects and procedure as given in the preliminary OPA regulation. DSC regulation (where the reimbursement money comes from) has not yet been issued.

As for other regulations, the various departments such as purchasing, automatically picks up changes in priorities and things affecting material; marketing takes up prices, allocation of products under PDO 20, etc. In following this departmentalized system, however, each department is separately charged with the responsibility of following through to obtain compliance, with the information filtering on down to field men, station operators and others.

Regulations needing clarification or interpretation in layman's language are taken up with the legal department.

Very much the same method is followed by Standard of Indiana, except that Standard has a committee on governmental regulation composed of representatives of the various departments which meets from time to time as necessity requires. On the committee is a member of the law department to give interpretations. Heads of the various departments then break the regulations down and pass instructions out to the field in letters and bulletins. Regulations concerning personnel are studied by the industrial relations department and are then passed on to the other departments for handling and compliance.

Liaison Formed

Heads of branch offices or divisions with field contact men such as those in liaison with service stations, check for compliance.

Even branch offices of oil companies handling only specialty lines watch their Ps and Qs when it comes to abiding by government agency regulations. Sun Oil Co. branch office in Chicago does a wholesale business only, handling lubes in tank car lots to jobbers, plus wholesale sales of industrial oils to the smoke stack trade.

"We of course are not affected by many government orders coming out," P. A. Watson, division manager said, "but we still have to keep on the watch for those that do concern us. We have a bound book from Washington containing instructions applying to our specialty operation, but we also take OIL-LAW-GRAM to check for changes and for new orders. Each one is studied that affects us. And we abide by them!"

Sun's local organization is relatively small and passing on instruction on the few regulations affecting them is not difficult.

Small independent refiners in the Midwest, in proportion to their size, are probably affected more than the average, by the mass of government regulations, but Worth Refining Co. with a plant at Blue Island, Ill., has a system. T. E. ("Tommy") Thompson, president, and George E. Phoenix, vice president, have the first look at all new regulations. Those that concern crude oil for the plant—which could use more than it's now getting—Mr. Thompson goes over with a fine tooth comb. Those pertaining to sales are examined by Mr. Phoenix.

Make Interpretations Themselves

"We make interpretations ourselves based on good common sense," Mr. Phoenix said, "and pass them on down the line to employes for compliance. The original orders we keep in our own convenient file for ready reference. We check price ceilings on sales, make our reports on gasoline octane number, crude runs at the refinery and other statements to PAW, OPA, etc. It's a job to watch all regulations, but striving for compliance since the regulations started coming has become a habit. Ordinarily Mr. Thompson and I would not have the time to give it the personal attention we do, but we are now operating at only 50% capacity because we do not have enough crude, so have a little time."

Apex Motor Fuel Co., Melville Keim, large distributors of fuel oil and motor fuel in metropolitan Chicago: "Our handling of government orders can be summarized briefly. We get copies of them and send them to our customers and do not depend entirely on our truck drivers, although our drivers are instructed too.

"Each order, directive or amendment is examined by our mail clerk, who has become very familiar with them. Regulations that pertain to gasoline, go to our gasoline department and those pertaining to fuel oil, to the fuel oil department. The regulations are studied by the heads of those departments, and bulletins explaining them are written and mailed direct to our customers, with copies going to our own drivers and other men concerned. The most important bulletins are sent to customers by registered mail. When customers receive a registered letter, they know what it contains affects them and will read it carefully."

Continental Oil Co., div. office, Chicago; J. L. Wait, assistant division manager: "We depend to a large extent on our home office in Ponca City, Okla., which sends us instructions from time to time, including information on all OPA, PAW and other government agency regulations. However, it of course takes time to get out detailed instructions on a national basis, so we keep an eye open ourselves. We feel we can't afford to miss any, and each order or amendment is carefully watched for compliance.

"As the orders and amendments come in, we study them in this office and write a short, interpretative letter or bulletin on them and send it to our people in the field in some instances, without waiting for instructions from Ponca City, if the subject requires quick action. Take for example, the amendment by OPA, cancelling gasoline inventory coupons on July 15. It had a limited time for turning in the old coupons in exchange for certificates. As soon as we received notice, we immediately got out a letter to bulk plant and service stations operators, urging them to get the coupons in at once."

PAW Shares Vast Detail Task On Oil Burners With OPA

NPN News Bureau

WASHINGTON — PAW was relieved this week, effective July 29, of the irksome and time-consuming task of having to pass on requests for reinstallation of oil heating equipment in small dwellings and for use of fuel oil to heat small structures.

Hereafter, as a result of amendments to PDO 13 and OPA's revised RO 11, the job of processing all requests for re-

installations of oil burning equipment in residences of less than four-family capacity and applications for fuel oil for space heating in other structures using less than 10,000 gals. per heating year will belong to OPA.

The rationing agency also will have sole jurisdiction over use of fuel oil burning space heaters.

PAW's responsibilities will be:

1. To continue to make final determinations regarding installations of new oil burning equipment in any structure.
2. To process requests for authority to reconvert equipment to use fuel oil in buildings housing four or more families and in other buildings where consumption of fuel oil is 10,000 gals. or more per heating year.
3. To handle all applications for use of fuel oil in new and reinstalled oil burning facilities for agricultural, commercial and industrial processing, with the proviso that appeals for such use will be granted "only if the applicant establishes that the use of a solid fuel would entail an exceptional and unreasonable hardship."

Practical effect of the exclusive functions delegated to OPA will be to place responsibility for exercise of those functions in the local ration boards and to relieve PAW of much paper work. Size of the burden PAW is getting out from under is indicated by the fact that in one recent week PAW's Dist. 1 office received about 1800 applications.

Gasoline Rationing Committee Approved by OPA in Chicago

NPN News Bureau

CHICAGO—OPA Chicago metropolitan office has announced several changes and the final approval of the gasoline rationing advisory committee appointed for the Metropolitan Chicago district. Ten man committee formally announced has swelled to a 12-man advisory committee and A. J. Sus, Sinclair Oil Refining Co., and Bryon Reid, Socony-Vacuum Oil Co., Inc. have withdrawn from the original committee.

Acceptances have been received from each of the twelve men who will begin almost immediate action to bring about greater compliance with OPA regulations from the industry in the Chicago metropolitan area. Committee members are: D. G. Thompson, Texas Company; Raymond J. Kelly, Deep Rock Oil Corp.; W. P. Bergen, Anchor Oil and Gas Company, Argo, Ill.; Milton Erickson, Shell Oil Co., Inc.; C. S. Rosenthal, Apex Motor Fuel Company; J. M. Homer, Standard Oil Company of Indiana; Bert Stallions, Perfect Power Corp.; Leslie Lewis, Will-DuPage County Service, Joliet, Ill.; B. M. Provis, Chicago Retail Gasoline Dealers Assn.; B. G. Corsgreen, Wells Petroleum Co.; Karl D. Friend, Friend & Beck, Inc.; and R. R. Wible, Socony-Vacuum Oil Co. The chairman has not yet been appointed.

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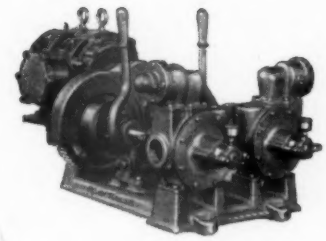

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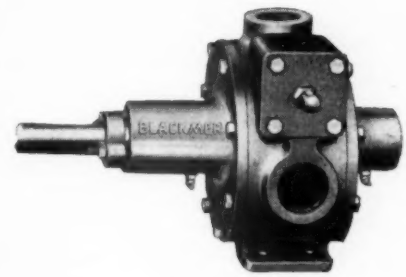

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California Natural Gas Assn. Offers Its 'Lexicon' To Clarify Industry's Definitions, Now in Muddle

NPN News Bureau

CLEVELAND—Recommended definitions, as an initial step in securing uniformity of natural gasoline terminology, have recently been released by the California Natural Gasoline Assn. The difference in interpretations of terms in general use for the natural gas and natural gasoline industries, has been realized for several years, R. W. Heath, past president of C.N.G.A. tells NPN.

Since the war, these differences have multiplied by reason of filling out reports and forms related to the war effort, he explained, and in many cases this has resulted in erroneous compilation of vital data.

To remedy this situation, a committee was formed by the association to develop a Natural Gas and Natural Gasoline lexicon. The committee found that the divergences of interpretations were more general than was originally expected, and that some compromise of definitions would be necessary. For this same reason, the association did not feel free to standardize terminology at this time. Realizing that the terms were of obvious value and would serve as a big step toward eventual industry adoption of generally accepted terms, it was decided to release recommended definitions. This the association believes will serve as an initial step in securing uniform understanding, which would be of utmost importance to all phases of the petroleum industry.

Following is the terminology as developed by the Natural Gasoline Assn. committee. (NPN would be very glad to have comments from others interested in this step toward standardization of these basic terms on a nation-wide basis):

NATURAL GAS AND NATURAL GASOLINE TERMINOLOGY

1. NATURAL GAS:

Any gas of natural origin consisting principally of hydrocarbons.

2. FORMATION GAS:

Any Natural Gas producible directly from its original source.

3. WET GAS:

Any unprocessed Natural Gas which is producible from stratum containing crude petroleum and/or condensate (specifically, the term "wet" bears no inference as to the water content of the gas).

4. DRY GAS:

Any Natural Gas that is producible from a stratum that does not contain crude petroleum and/or condensate.

5. RESIDUE GAS:

Any Natural Gas remaining after the extraction of liquid products from wet gas (The term Dry Gas has often been used in lieu of the preferable term Residue Gas).

6. SHRINKAGE:

The reduction in volume of the Wet Gas input to a Processing Plant due to the extraction of liquid products. (Note: Does not include Plant Fuel).

7. PLANT FUEL:

Any natural gas used for fuel in the Processing Plant.

8. PROCESSING PLANT:

Any plant that is used to process Natural Gas for the extraction of hydrocarbons and/or other substances.

9. NATURAL GASOLINE PLANT:

A Processing Plant operated for the purpose of extracting Natural Gasoline and/or lighter hydrocarbons from Wet Gas.

10. CONDENSATE PLANT:

Any Processing Plant extracting liquid hydrocarbons from a Wet Gas containing condensate.

11. COMPRESSOR PLANT:

Any plant for compressing Natural Gas or other hydrocarbon vapors. It is a unit of a Processing Plant if used for compressing Wet Gas that is being processed for the extraction of liquids.

12. CIRCULATED GAS:

Any Natural Gas which is used to produce fluid from wells and which is immediately returned from the well (such as Gas-lift Gas), or which rapidly migrates to an adjoining well and is currently produced along with the Formation Gas produced by such a well.

13. REPRESSURE GAS:

Any Natural Gas injected into a formation capable of producing crude petroleum and/or condensate to aid in maintaining pressure in an underground reservoir for the purpose of assisting in the future recovery of any fluid (Pressure Maintenance).

14. STORAGE GAS:

Any Natural Gas returned to an underground reservoir for the purpose of creating a Natural Gas reserve but not intended for the purpose of aiding in the recovery of any fluid.

15. UNCONSERVED GAS:

Any Natural Gas that is blown to the air.

16. VAPOR:

Any gas evaporated from liquid hydrocarbons or extracted from Wet Gas within the Processing Plant and which requires further processing for the recovery of liquid products.

17. NATURAL GASOLINE COMPANY:

Company engaged in the extraction of Natural Gasoline.

18. GAS COMPANY:

A Company engaged in the business of purchasing and reselling dry gas or residue gas.

19. LIQUEFIED PETROLEUM GAS (L.P.G.):

Any hydrocarbon mixture, the predominant components of which consist of normal butane or isobutane, or propane, or mixtures thereof, in any ratio and which is produced and marketed for fuel purposes.

20. NATURAL GASOLINE:

Any liquid hydrocarbon mixture that contains substantial quantities of pentanes and heavier, which has been extracted from Natural Gas and has an end point not greater than that of Motor Gasoline.

21. CONDENSATE:

The liquid produced by a reduction of pressure, which may be accompanied by a reduction of temperature (Retrograde Condensation) from a high pressure Wet Gas which existed in the formation in a single gaseous phase.

22. LIQUEFIED GAS STOCK:

Liquefied hydrocarbons consisting of isopentane or lighter materials substantially pure, or mixtures in any ratio which have been produced for further processing.

23. STANDARD CUBIC FOOT:

A Standard Cubic Foot of Gas is that quantity of gas which occupies One Cubic Foot at standard conditions, i.e., at a temperature of 60° Fahrenheit and an absolute pressure of 14.73 lbs. per square inch.

24. M. C. F.:

1-000 Standard Cubic Feet.

Holds War Disabled Are True Asset to Industry But Urges Special Compensation Setup for Injuries

NPN News Bureau

CLEVELAND — Disabled soldiers, sailors and marines, now returning in increasing numbers from the world battle fronts, represent a vast untapped manpower pool for both war and peace industries, Ray Murphy, past national commander of the American Legion and general counsel, Assn. of Casualty and Surety Executives, told a nation-wide audience this week.

Pointing out that there is a widespread and entirely erroneous impression prevailing that insurance companies advise employers against the employment of disabled persons, Mr. Murphy sharply and forcefully emphasized that this impression is completely and utterly false. He said that his association had a membership of 62 leading capital stock and casualty and surety companies, and that the member companies recently issued a declaration of attitude on the employment of disabled war veterans and other disabled persons.

This declaration stresses the conclusions of studies on the question of employment for handicapped workers, which revealed that physically handicapped workers compare very favorably with able-bodied workers in respect to absenteeism, labor turnover, accident rate and productivity.

Fear by employers that they might be held liable in the case of a second injury resulting in the worker's total disability, may cause hesitation in the employment of these disabled persons, Mr. Murphy said. He said that these bad developments do occur, though very rarely and that when they did it is not fair to hold the employer liable for the worker's total disability, but rather only for the second injury sustained in his employ.

As a solution to this second-injury problem, the Assn. of Casualty and Surety Executives is advocating the enactment of a sound, adequate second-injury fund law in every state, under which the employer pays compensation for the second injury only. The worker's additional disability caused by the combination of his two disabilities would be paid out of a fund to which all employers and insurance companies would contribute. He concluded:

"We are obligated to those who are wounded and return to civilian life in a physically handicapped condition. But we must consider employment of disabled persons as much more than our obligation. The disabled person can be a great asset to our nation's industry and economy, contributing his share of our future wealth and certain progress."

Market Reports

ATLANTIC COAST—Markets steady and prices unchanged. Gasoline shortage increasingly serious although one supplier in Virginia area reported "getting enough of product to carry on through pipeline delivery." Several marketers reported 72-octane gasoline being delivered to trade, but available supplies will last only short while. Deliveries of 70-octane will be in effect very soon, they said. One refiner in New York area reported supply of 72-octane completely exhausted. Suppliers generally non-committal on OPA action to reduce housebrand margin.

° ° °

PENNSYLVANIA — Several Pennsylvania refiners reported fuel oils tight and building of stocks stationary because cracking plants making high-octane gasoline needed all the fuel oil that is being made. Kerosine stocks, which were ample at the beginning of the week, are being rapidly depleted as industrial requirements increase.

Pennsylvania neutrals handled by Midwestern brokers reported selling at 28c and 30c for 150 and 200 vis. 25 p.t., respectively, an increase of 1c over previous price. Price range of neutrals in Western Pennsylvania remains unchanged at 28-33c for 200 vis. and 26-31c for 150 vis. Industrial and dry cleaner naphtha demand is so great that refiners have had to import stocks to meet heavy demand.

° ° °

CALIFORNIA—Prices remain stable. Ceilings prevail in all products with distillate and stove oil shortest of all.

An increased demand for service stations closed by the war is reported. For the most part, however, companies are asking five-year leases with rentals slightly less than half prewar scale. Some of the smaller refiners are now taking six month and one-year leases on service stations at about one third of prewar prices. It is reported that these smaller operators hope this way to hold some of the larger service stations, originally built by major companies, after the war is over.

° ° °

MIDWEST—Michigan refiners last week reported complete exhaustion of 72 octane storages, bringing them down to 70 octane level for housebrand gasoline. Other Midwestern refiners, with still some storages of the 72 octane product, are tapering off shipments of the higher octane gasoline and blending remaining storages of it with product of a lower octane to produce a housebrand gasoline ranging from 69 to 71 octane. Refiners predict actual cleanup period may last another 30 days, however, after which some expect housebrand to fall somewhere between 68 and 69.5. Revision of housebrand price ceilings is expected this week or early next week.

Acute shortage of heating oils is in prospect for next season. Refiners who normally would have substantial storages of heating oils at this time have little on hand. Factors entering into an even more serious picture than that of last winter, refiners feel, are replacement schedule which has undermined large scale attempts to store material for several months now and, also, lower yields of the oils because of increased manufacture of military products. Demand for distillates has gained some momentum during past two weeks and present supply situation indicates suppliers may have to substitute kerosine for heavier distillates next fall when shortage of Nos. 1, 2 and 3 becomes even more pronounced.

° ° °

GULF COAST — Markets continue steady. Prices firm at current posted levels. Continued strong demand for gasoline from eastern distributors reported. Refiners' storages of 72 Octane gasoline practically depleted. One refiner said he had stock to last only until end of week and would then begin selling 70-octane grade. All refined products limited to regular trade.

° ° °

MIDCONTINENT—Refiners reported transport truck trouble during the week as some of them applied to ODT for tank car permits as substitution for trucks. Lack of transportation has put many behind in orders. North Texas refiner reported open spot sale of 10 cars regular gasoline at 6c f.o.b. Group 3 shipped north in sellers' cars. Storages of 72 octane now depleted with refiners filling orders with 70 octane.

Kerosine movement not excessive; refiners are trying to build inventories for winter demand. Asphalt demand was reported quite heavy in Arkansas.

CRUDE PRICES

Since changes in crude oil prices are so few, the two pages of crude oil price tables hereafter will be printed only when there are sufficient changes in prices to warrant.

In the meantime a record is being kept in the Cleveland office of NPN and OILGRAM from which the publishers will be glad to make proofs, or letters or affidavits as to what the prices are, and without charge to regular subscribers.

New OPA stripper subsidy prices take effect Aug. 1. *(See NPN July 12, p. 36 for prices).*

Crude Price Changes

No changes reported during week ended July 19. For latest table of crude prices published, see NPN, June 14, pages 61, 62 and 56.

Summary of Daily Gasoline Prices (July 24 to July 31)

	Monday July 31	Friday July 28	Thursday July 27	Wednesday July 26	Tuesday July 25
U. S. Motor (ASTM octane)					
76 octane Ethyl:					
Oklahoma	6.75	6.75	6.75	6.75	6.75
Mid-Western (Group 3 basis)	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7	7	7	7	7
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7 (2)	7 (2)	7 (2)	7 (2)	7 (2)
72 or 70 octane:					
Oklahoma	6	6	6	6	6
Mid-Western (Group 3 basis)	6	6	6	6	6
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
63-66 octane:					
Oklahoma	5.625 (2)	5.625 (2)	5.625 (1)	5.625 (1)	5.625 (1)
Mid-Western (Group 3 basis)	5.625	5.625	5.625	5.625	5.625
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)
60 octane & below:					
Oklahoma	5.25	5.25	5.25	5.25	5.25
Mid-Western (Group 3 basis)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.25	5.25	5.25	5.25	5.25
Motor Gasoline- Housebrand					
New York harbor	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4
New York harbor, barges	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3
Philadelphia district	9.2	9.2	9.2	9.2	9.2
Baltimore district	8.95	8.95	8.95	8.95	8.95
Motor Gasoline:					
Western Penna. Bradford-Warren:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95
Western Penna. Other Districts:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.45	7.75 - 8.45	7.75 - 8.45	7.75 - 8.45	7.75 - 8.45

Refinery Operations

(American Petroleum Institute figures in thousands of barrels of 42 gal. each. Figures include reported totals plus estimate of unreported amounts and are therefore on a Bureau of Mines basis.)

Districts	Daily Potential Refining Capacity Week Ended July 22	Daily Potential Refining Capacity Week Ended July 15	Per Cent of Refining Capacity Reporting Week Ended July 22	Per Cent of Refining Capacity Reporting Week Ended July 15	Daily Average Crude Runs to Stills Week Ended July 22	Daily Average Crude Runs to Stills Week Ended July 15	Per Cent of Reporting Capacity Operated Week Ended July 22	Per Cent of Reporting Capacity Operated Week Ended July 15
Combined**	2,518	2,518	90.3	90.3	2,439	2,406	96.9	95.6
Appalachian (Dist. No. 1)	130	130	83.9	83.9	102	103	78.5	79.2
Appalachian (Dist. No. 2)	47	47	87.2	87.2	56	64	119.1	136.2
Ind., Ill., Ky.	824	824	85.2	85.2	797	759	96.7	92.1
Okla., Kans., Mo.	418	418	80.2	80.2	374	377	89.5	90.2
Rocky Mt. (Dist. No. 3)	13	13	17.0	17.0	13	13	100.0	100.0
Rocky Mt. (Dist. No. 4)	141	141	58.3	58.3	102	103	72.3	73.0
California	817	817	89.9	89.9	801	750	98.0	91.8
Total U. S.—B. of M. Basis	4,908	4,908	87.2	87.2	4,684	4,575	95.4	93.2
U. S.—B. of M. Basis July 24, 1943					3,954			

Districts	Gasoline Production at Refineries inc. Natural Blended Week Ended July 22	Gasoline Production at Refineries inc. Natural Blended Week Ended July 15	Stocks of Finished and Unfinished Gasoline Week Ended July 22	Stocks of Finished and Unfinished Gasoline Week Ended July 15	Total Stocks Gas Oil & Distillates Week Ended July 22	Total Stocks Gas Oil & Distillates Week Ended July 15	Total Stocks Residual Fuel Oil Week Ended July 22	Total Stocks Residual Fuel Oil Week Ended July 15
Combined**	7,289	7,215	36,274	37,112	20,759	19,518	16,323	15,730
Appalachian (Dist. No. 1)	275	317	2,300	1,948	563	831	320	314
Appalachian (Dist. No. 2)	197	194	1,565	1,058	187	589	177	163
Ind., Ill., Ky.	2,739	2,699	18,756	18,443	5,288	5,987	3,966	3,783
Okla., Kans., Mo.	1,346	1,429	6,860	6,997	1,606	1,534	1,596	1,547
Rocky Mt. (Dist. No. 3)	35	37	62	68	3	3	36	35
Rocky Mt. (Dist. No. 4)	328	358	2,272	2,360	340	334	604	597
California	2,034	1,834	14,061	14,266	8,767	8,375	32,293	32,163
Total U. S.—B. of M. Basis	14,243	14,083	*82,150	82,252	37,513	37,171	55,315	54,332
U. S.—B. of M. Basis July 24, 1943	11,367		74,356		33,863		67,161	

*Finished 69,789,000 bbls.; Unfinished 12,361,000 bbls.

**Includes East Coast, Inland Texas, Texas Gulf, Louisiana Gulf and North Louisiana-Arkansas districts.

U. S. Crude Oil Production

(American Petroleum Institute figures)

	WEEK ENDED Barrels July 22 (Daily Average)	Barrels July 15 (Daily Average)
Oklahoma	341,200	341,250
Kansas	285,300	278,800
Nebraska	900	900
Texas	2,067,300	2,067,300
Louisiana	357,450	357,550
Arkansas	80,500	80,550
Mississippi	44,950	44,050
Alabama	200	150
Florida	50	50
Illinois	208,250	196,950
Indiana	12,650	12,850
Eastern (Ill., Ind. & Ky. excluded)	61,400	66,650
Kentucky	23,150	24,350
Michigan	49,600	50,300
Wyoming	87,750	87,300
Montana	22,100	22,100
Colorado	8,900	8,450
New Mexico	108,500	108,000
California	855,300	854,800
Total, U. S.	4,615,450	4,602,350

Crude Oil Stocks

(Bureau of Mines Figures in thousands of bbls.)

Grade or Origin	July 15	July 22	Change from July 15
Pennsylvania Grade	2,676	2,585	— 91
Other Appalachian	1,434	1,555	+ 121
Lima-Michigan	912	942	+ 30
Illinois-Indiana	14,376	14,476	+ 100
Arkansas	2,866	2,969	+ 103
Kansas	8,669	8,667	— 2
Louisiana:	13,288	13,181	— 107
Northern	3,452	3,368	— 84
Gulf Coast	9,836	9,813	— 23
Mississippi	1,008	810	— 198
New Mexico	6,275	6,240	— 35
Oklahoma	31,248	31,117	— 131
Texas:	111,057	110,780	— 277
East Texas	21,913	21,375	— 538
West Texas	29,910	30,544	+ 634
Gulf Texas	30,802	30,922	+ 120
Other Texas	28,432	27,939	— 493
Panhandle	6,461	6,257	— 204
North	5,966	6,079	+ 113
South	6,288	6,013	— 275
Other	9,717	9,590	— 127
Rocky Mountain	8,701	8,382	— 319
California	21,872	21,560	— 312
Foreign	2,131	2,030	— 101
Total gasoline-bearing in U. S.	226,513	225,294	—1,219
Heavy in Calif.	6,016	5,994	— 22

Crude Production & Runs to Stills

(Millions of Barrels)

N.P.N. Gasoline Index

	Dealer T.W. Cents	Tank Car Per Gal.
July 31	10.51	6.17
Month ago	10.57	6.17
Year ago	10.37	6.97

Dealer index is an average of "undivided" dealer prices, ex-tax, in 50 cities.

Tank car index is weighted average of following wholesale markets for regular-grade gasoline, FOB refineries or terminals: Okla., Mid-Western, W. Penna., Calif., N. Y. Harbor, Philadelphia, Jacksonville, Boston and Gulf Coast.

Pennsylvania Crude Runs

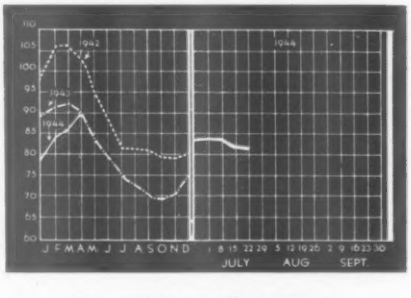
(Compiled by National Petroleum Assn. from reports of all companies refining Pennsylvania crude. Figures in bbls.)

DAILY AVERAGE

Week Ended July 22, 1944	Week Ended July 15, 1944	Week Ended July 17, 1943
65,560	64,285	73,156

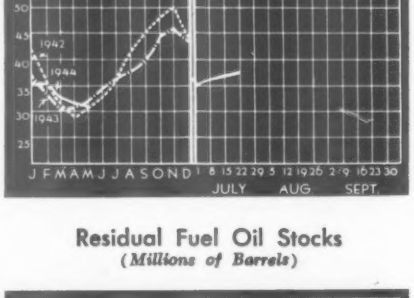
Gasoline Stocks

(Millions of Barrels)



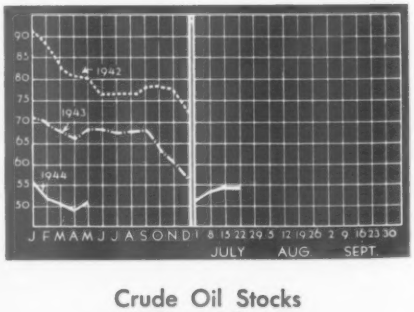
Gas Oil & Distillate Stocks

(Millions of Barrels)



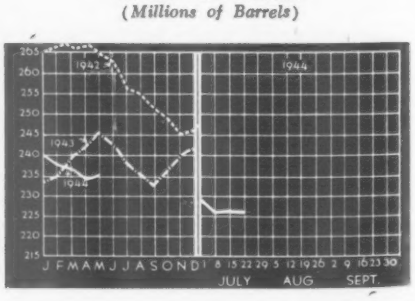
Residual Fuel Oil Stocks

(Millions of Barrels)



Crude Oil Stocks

(Millions of Barrels)



OIL PRICE SECTION

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At Refineries and Terminals and by Tank Wagon

Prices herewith are reproduced from Platt's *OILGRAM* Daily Oil Price Service, associated with National Petroleum News, whose representatives in all NPN-OILGRAM offices devote their time exclusively to reporting oil industry prices everywhere.

Prices shown are actual sales prices, or quotations meaning sellers' general offers or posted prices; for current sales and shipment; for the business day or period stated; except Tank Wagon prices, prices are for bulk lots such as tank car and motor transport; barge or tanker cargo lot prices are identified; FOB refineries or terminals; in cents per gal. except where shown in bbls. of 42 gals.; ex all fees and taxes; for crude oil and its products lawfully produced and transported; reported as received by *OILGRAM* and National Petroleum News but not guaranteed; for subscribers' private use only and not for resale or distribution or publication. For further details of price conditions apply to any *NPN-OILGRAM* office or see back of any *OILGRAM* Price Service invoice.

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Refinery Prices

Gasoline —U. S. Motor (A S T M) except where otherwise specified

Prices in Effect	July 31	July 24
OKLAHOMA		
76 oct. Ethyl...	6.75	6.75
72 or 70 oct....	6	6
63-66 oct.....	5.625 (2)	5.625 (2)
60 oct. & below.	5.25	5.25
60-62, 400 e.p...	....	....
MID-WESTERN (Group 3 basis)		
76 oct. Ethyl...	6.75 – 7.25	6.75 – 7.25
72 or 70 oct....	6	6
63-66 oct.....	5.625	5.625
60 oct. & below..	5.2 – 5.25	5.2 – 5.25
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl...	7	7
72 or 70 oct....	6	6
63-66 oct.....	5.625 (1)	5.625 (1)
60 oct. & below..	5.2 – 5.25	5.2 – 5.25
60-62, 400 e.p...	....	....
W. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl...	7 (2)	7 (2)
72 or 70 oct....	6	6
63-66 oct.....	5.75 (1)	5.75 (1)
60 oct. & below..	5.25	5.25
CENT. W. TEX. (Prices to truck transports)		
76 oct.....	7 (2)	7 (2)
70 oct.....	6 (2)	6 (2)
67-69 oct.....	....	....
62 oct & below..	5.25 (2)	5.25 (2)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
60 oct. & below..	No Price	No Price
60-62, 400 e.p...	No Price	No Price
KANSAS (For Kansas destinations only)		
76 oct. Ethyl...	7.25 – 7.5	7.25 – 7.5
70 oct.....	6.25 – 6.3	6.25 – 6.3
63-66 oct.....	5.9 (2)	5.9 (2)
60 oct. & below.	5.5	5.5
ARK. (For shipment to Ark. & La.)		
76 oct. Ethyl...	7 (1)	7 (1)
72 oct., leaded..	Not made	Not made
70 oct. "	5.875 (1)	5.875 (1)
62 oct. "	....	....
60 oct. & below, leaded.....	5.25 (1)	5.25 (1)
WESTERN PENNA. (Motor gasoline)		
Bradford-Warren:		
"Q" Gasoline, Min.		
70 Oct. (ASTM)	7.75 – 8.95	7.75 – 8.95
Other districts:		
"Q" Gasoline, Min.		
70 Oct. (ASTM)	7.75 – 8.45	7.75 – 8.45

Prices in Effect	July 31	July 24
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
U.S. Motor: (Oct. ASTM):		
70 oct.....	8 – 8.5	8 – 8.5
67-69 oct.....	....	....
Str. run gasoline, excluding Detroit shpt.....	6	6
OHIO (S. O. Ohio quotations for statewide delivery and subject to exceptions for local price disturbances).		
72 or 70 oct....	8.375	8.375
CALIFORNIA U.S. Motor:		
76 oct. (Ethyl)....	7.5 – 8.75	7.5 – 8.75
70 oct. (regular)..	6.5 – 7.75	6.5 – 7.75
65 oct. & below (3rd grade).....	6.5 – 6.75	6.5 – 6.75

Kerosine, & Gas Fuel Oils

OKLAHOMA		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range Oil.....	4	4
No. 1 P.W.....	3.875	3.875
No. 1 straw.....	....	....
No. 2 straw.....	3.625	3.625
No. 3 fuel.....	3.5 (2)	3.5 (2)
U. G. I. Gas Oil...	....	....
No. 6 fuel.....	....	....
14-16 fuel.....	$0.97 (2)	$0.97 (2)
MID-WESTERN (Group 3 basis)		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range Oil.....	4 –4.1 (2)	4 – 4.1(2)
No. 1 p.w.....	3.875	3.875
No. 2 straw.....	3.625	3.625
No. 3.....	....	....
No. 5.....	....	....
No. 6.....	$0.80 (1)	$0.80 (1)
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
41-43 grav. w.w....	4.375	4.375
42-44 grav. w.w....	4.5 (1)	4.5 (1)
No. 1 P.W.....	3.875 (1)	3.875 (1)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
42-44 grav. w.w...	4.5 (1)	4.5 (1)
No. 1 straw.....	No Price	No Price
KANSAS (For Kansas destinations only).		
41-43 grav. w.w...	No Price	No Price
42-44 grav. w.w...	4.7 – 4.75	4.7 – 4.75
No. 1 p.w.....	4.1 (2)	4.1(2)
No. 6 fuel.....	$0.85	$0.85
ARK. (For shipment to Ark. and La.)		
41-43 grav. w.w...	....	....
42-44 w.w. kero...	4.5 (1)	4.5 (1)
No. 1.....	4 (1)	4 (1)
No. 2.....	3.625 (1)	3.625 (1)
No. 3 fuel.....	3.5 (1)	3.5 (1)
Tractor fuel, for shpt. to Ark. points only....	5.125 (1)	5.125 (1)
Diesel fuel 52 & below.....	4 (1)	4 (1)
Diesel fuel 58 & above.....	4.25 (1)	4.25 (1)
WESTERN PENNA.		
Bradford-Warren:		
45 grav. w.w.....	6.55 – 8.05	6.55 – 8.05
46 grav. w.w.....	6.675 (1)	6.675 (1)
No. 1 fuel.....	6.55-8.05 (b)	6.55–8.05(b)
No. 2 "	6.125–7.625(b)	6.125–7.625(b)
No. 3 "	6.25–7.75 (1&b)	6.25–7.75(1&b)
36-40 gravity.....	6.625–6.75 (2)	6.625–6.75(2)
(b) Highs and lows for Schedule D area; in RPS 88 and outside Schedule D area, respectively.		
Other districts:		
45 grav. w.w.....	7.25 – 7.925	7.25 – 7.925
46 grav. w.w.....	7.25 – 7.625	7.25 – 7.625
47 grav. w.w.....	7.375– 7.875	7.375– 7.875
No. 1 fuel.....	6.875– 7.375	6.875– 7.375
No. 2 "	6.75 – 7.375	6.75 – 7.375
No. 3 "	6.75 – 7.375	6.75 – 7.375
36-40 grav. Pittsburgh dist. prices excluded.....	6.625– 7.375	6.625– 7.375
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
47-49 gravity w.w.	5.8 – 6	5.8 – 6
P.W. Distillate...	5.5	5.5
No. 3 gas oil, Straw	5	5
U.G.I. gas oil.....	4.5 (2)	4.5 (2)
Fuel Oils (*Vis. at* 100).		
300-500 Vis.....	....	....
100-300 Vis.....	4.5	4.5
OHIO (S. O. quotations for statewide delivery)		
Kerosine.....	7	7
CALIFORNIA		
40-43 grav. w.w...	5 – 7	5 – 7
San Joaquin Valley:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20 (2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (2)	5 (2)
Los Angeles:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20(2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (1)	5 (1)
San Francisco:		
Heavy fuel.....	$1.15(2)	$1.15 (2)
Light fuel.....	$1.25(2)	$1.25 (2)
Diesel fuel.....	4.5 (2)	4.5(2)
Stove dist.....	5.5 (1)	5.5(1)

NOTE: All above heavy fuels meet Pacific specification 400; light fuel, spec. 300; Diesel fuels, spec. 200; and stove distillate, spec. 100.

Lubricating Oils

Prices in Effect	July 31	July 24
WESTERN PENNA.		
Prices are for sales made, or offers reliably reported, to jobbers & compounders only.		
Viscous Neutrals—*No. 3 col. Vis. at* 70°*F.*		
200 Vis. (180 at 100°) 420-425 fl.		
0 p.t.....	38 (1)	38 (1)
10 p.t.....	37 (1)	37 (1)
15 p.t.....	36 (1)	36 (1)
25 p.t.....	28–33	28–33
150 Vis. (143 at 100°) 400-405 fl.		
0 p.t.....	36 (1)	36 (1)
10 p.t.....	35 (1)	35 (1)
15 p.t.....	34 (1)	34 (1)
25 p.t.....	26–31	26–31

NOTE: Limited quantity neutrals available to regular trade.

Cylinder Stocks

Brt. stk., 145-155 *vis. at* 210°, 540-550 fl., *No. 8 col.*

10 p.t.....	30.5 (1)	30.5 (1)
15 p.t.....	29.5 (1)	29.5 (1)
25 p.t.....	25	25
600 S.R. filterable.	15	15
650 S.R.....	15.5	15.5
600 fl.....	16	16
630 fl.....	17	17

MID-CONTINENT (F. o. b. Tulsa)

Neutral Oils (*Vis. at* 100° *F. to* 10 *P.P.*)

Pale Oils:

Vis. Color		
60-85—No. 2....	7.5	7.5
86-110—No. 2...	7.5 – 8.5	7.5– 8.5
150—No. 3.....	11 –11.5	11 –11.5
180—No. 3.....	11.5 –15	11.5–15
200—No. 3.....	12 –15	12 –15
250—No. 3.....	14 –16.5	14 –16.5
280—No. 3.....	15 –17	15 –17
300—No. 3.....	16 –18	16 –18
Red Oils:		
180—No. 5.....	11.5 (1)	11.5 (1)
200—No. 5.....	12	12
280—No. 5.....	No Price	No Price
300—No. 5.....	16-17.5 (2)	16-17.5 (2)

NOTE: Discounts of 0.5c to 1c on bright stock and 0.5c to 2c allowed for neutrals on contracts, 10 car lots, and to "meet competition." Brokers offering at greater discounts.

Bright Stock—*Vis. at* 210°		
200 Vis. D.....	27 (1)	27 (1)
150-160 Vis. D:		
0 to 10 p.p.....	23	23
10 to 25 p.p.....	22.5–23	22.5–23
25 to 40 p.p.....	23 (1)	23 (1)
150-160 Vis. E....	22 (1)	22 (1)
120 Vis. D:		
0 to 10 p.p.....	22 (2)	22 (2)
600 S.R. Dark Green.....	8.5 (1)	8.5 (1)
600 S.R. Olive Green.....	10–11 (2)	10–11 (2)
631 S.R.....	....	....
Black Oil.....	....	....

NOTE—Discounts of 0.5c to 2c off for contracts to "meet competition". Brokers offerings at greater discounts.

SOUTH TEXAS Neutral Oils

Pale Oils (*Vis. at* 100°*F.*)

Vis. Color		
100 No. 1½-2½.	6.5	6.5
200 No. 2-3.....	8.75	8.75
300 No. 2-3.....	9.25	9.25
500 No. 2½-3½.	10	10
750 No. 3-4.....	10.25	10.25
1200 No. 3-4.....	10.375	10.375
2000 No. 4.....	10.5	10.5

(Continued on next page)

NOTE—Parenthetical figures after prices indicate number of companies quoting when less than three companies are quoting.

NOTICE—Owing to great demand, refiners generally limit quotations to regular customers and refuse bids, though higher, from others. Refiners' prices and sales shown; bids reported in market leads.

Refinery Prices (Continued)

Prices in Effect	July 31	July 24
Red Oils:		
100 No. 5-6	6.5 (2)	6.5 (2)
200 No. 5-6	8.75	8.75
300 No. 5-6	9.25	9.25
500 No. 5-6	10	10
750 No. 5-6	10.25	10.25
1200 No. 5-6	10.375	10.375
2000 No. 5-6	10.5	10.5

CHICAGO (From Mid-Continent p.l. crude.)
Neutral oils *vis. at* 100° *F. to* 10 *p. p.*

Pale Oils		
Vis. Color		
60-85—No. 2	9 (1)	9 (1)
86-110—No. 2	9.25 (1)	9.25 (1)
150—No. 3	12.5 (1)	12.5 (1)
180—No. 3	13 (1)	13 (1)
200—No. 3	13 (1)	13 (1)
250—No. 3	14 (1)	14 (1)
Red Oils:		
180—No. 5	13 (1)	13 (1)
200—No. 5	13 (1)	13 (1)
250—No. 5	14 (1)	14 (1)
280—No. 5	15 (1)	15 (1)
300—No. 5	15.5 (1)	15.5 (1)

Note: Viscous oils, 15 to 30 p.p. are quoted 0.5c lower; 60-85 and 86-110 No. 2 non-viscous oils, 15 to 30 p.p., 0.25c lower.

Unfiltered Steam Refined: (*Viscosity at* 210°)		
140	11.5 (1)	11.5 (1)
160	12.5 (1)	12.5 (1)
280	13.5 (1)	13.5 (1)
Bright stocks, 160 *vis. at* 210 *No.* 8 *color:*		
0 to 10 p.p.	24 (1)	24 (1)
15 to 25 p.p.	23.5 (1)	23.5 (1)
30 to 40 p.p.	21.5 (1)	21.5 (1)
E filtered Cyl. Stock	15.5 (1)	15.5 (1)

Note: To obtain prices delivered in Chicago, add 0.25c per gal.

Natural Gasoline

(Group 3 & Breckenridge prices are to blenders on freight basis shown below. Shipments may originate in any Mid-Continent manufacturing district.)

FOB GROUP 3		
Grade 26-70	4.75 (Quote)	4.75 (Quote)
FOB BRECKENRIDGE		
Grade 26-70	4.375 (Quote)	4.375 (Quote)

CALIFORNIA (FOB plants in Los Angeles basin)

21 pound vapor pressure for blending	4.75 - 5.375	4.75 - 5.375

Naphtha and Solvent

(*FOB Group* 3)

Stoddard solvent	6.625	6.625
Cleaners' naphtha	7.125	7.125
V.M.&P. naphtha	7.1 - 7.125	7.1 - 7.125
Mineral spirits	6.1 - 6.125	6.1 - 6.125
Rubber solvent	7.1 - 7.125	7.1 - 7.125
Lacquer diluent	7.375- 8.125	7.375- 8.125
Bensol Diluent	7.875- 8.625	7.875- 8.625
WESTERN PENNA.		
Bradford-Warren District:		
Stoddard Solvent	7.5 (1)	7.5 (1)
Other Districts:		
Untreated naphtha	7 -7.25(2)	7 -7.25(2)
Stoddard solvent	7.25 -7.5(2)	7.25 - 7.5(2)

OHIO (S. O. quotations for statewide delivery): V.M.&P. naphtha, D.C. naphtha, Varnolene &

Sohio solvent	10	10
Rubber solvent	9	9

Wax

WESTERN PENNA. (Bbls. C.L.)

White Crude Scale:		
122-124 A.m.p.	4.25 (2)	4.25 (2)
124-126 A.m.p.	4.25	4.25

OKLAHOMA (C.L. FOB Refinery)

Semi-refined:		
128 AMP min., white, 50 kilo bags	No Price	No Price
132-134 AMP, bbls.	5.25 (1)	5.25 (1)

CHICAGO (FOB Chicago district refinery of one refiner, in bags, carloads. Carloads, slabs loose 0.4c less. Melting points are EMP (ASTM) methods; add 3° to convert into AMP.)

Fully refined:		
122-124 (bags only)	5.6	5.6
125-127	6	6
127-129	6.25	6.25
130-132	6.55	6.55
132-134	6.8	6.8
135-137	7.55	7.55

Petrolatums

WESTERN PENNA. (Bbls., carloads; tank cars 0.5c per lb. less.)

Snow White	6.125- 7.25	6.125- 7.25
Lily White	5.375- 6.25	5.375- 6.25
Cream White	4.375- 5.5	4.375- 5.5
Light Amber	3.375- 4	3.375- 4
Amber	3.125- 3.75	3.125- 3.75
Red	3 - 3.5	3 - 3.5

Tank Wagon Prices

Commercial or consumer tank car, tank wagon, dealer, and service station prices for gasoline **do not include taxes;** *they do, however, include inspection fees as shown in general footnote. Gasoline taxes, shown in separate column, include* 1.5c *federal, and state taxes; also city and county taxes as indicated in footnotes. Kerosine tank wagon prices also do not include taxes; kerosine taxes where levied are indicated in footnotes. Dealer discounts are shown in footnotes. These prices in effect July* 31, 1944 *as posted by principal marketing companies at their headquarters offices, but subject to later correction.*

CONT'L OIL

	Conoco Bronz-e-s (*Reg*) †Tank Wagon	De-mand (*3rd Grade*) Wagon	Gasoline Taxes	Kerosine T.W.
Denver, Col.	11	10	5.5	11
Grand Junc., Col.	12.5	11.5	5.5	12.5
Pueblo, Col.	10.5	9.5	5.5	10.5
Casper, Wyo.	11.5	10.5	5.5	12
Cheyenne, Wyo.	11	10	5.5	11.5
Billings, Mont.	12.5	11.5	6.5	12.5
Butte, Mont.	13.5	12.5	6.5	13.5
Great Falls, Mont.	12.5	11.5	6.5	12.5
Helena, Mont.	13	12	6.5	13
Salt Lake City, Utah	13.5	12.5	5.5	14.5
Boise, Ida.	14.1	13.1	6.5	16.5
Twin Falls, Ida.	15.6	14.6	6.5	17
Albuquerque, N. M.	10	9	*7	9.5
Roswell, N. M.	9.5	8.5	*7	9
Santa Fe, N. M.	10.5	9.5	*7.5	10
Ft. Smith, Ark.	9.5	9.25	*7	9.5
Texarkana, Ark.	9	8	*5.5	9
Muskogee, Okla.	9.5	8.5	7	8.5
Oklahoma City, Okla.	9.5	8.5	7	8.5
Tulsa, Okla.	9.5	8.5	7	8.5

*Taxes: In gasoline tax column are included these city taxes—Albuquerque, & Roswell, 0.5c, Santa Fe, 1c. Texas 4c state tax applies within city limits of Texarkana, Ark.; Okla. 5.5c state applies within city limits of Ft. Smith, Ark.

†To consumers & Dealers.

S. O. N. J.

Esso (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
*Atlantic City, N. J.	10.2	10.7	4.5	10
*Newark, N. J.	10.2	10.7	4.5	10
Annapolis, Md.	10.55	11.05	5.5	....
Baltimore, Md.	9.95	10.45	5.5	10.8
Cumberland, Md.	11.35	11.85	5.5	12.3
Washington, D. C.	10.2	10.7	4.5	11.3
Danville, Va.	11.65	12.15	6.5	12.55
Norfolk, Va.	10.45	10.95	6.5	12.3
Petersburg, Va.	10.75	11.25	6.5	13.3
Richmond, Va.	10.75	11.25	6.5	13.3
Roanoke, Va.	11.95	12.45	6.5	12.8
Charleston, W. Va.	12.25	12.75	6.5	13.6
Parkersburg, W. Va.	11.55	12.05	6.5	13.3
Wheeling, W. Va.	11.55	12.05	6.5	13.9
Charlotte, N. C.	12.1	12.6	7.5	11.6
Hickory, N. C.	12.65	13.15	7.5	12.6
Mt. Airy, N. C.	12.5	13.0	7.5	11.8
Raleigh, N. C.	11.85	12.35	7.5	12.6
Salisbury, N. C.	12.15	12.65	7.5	13.0
Charleston, S. C.	10.95	11.45	7.5	....
Columbia, S. C.	11.8	12.3	7.5	....
Spartanburg, S. C.	12.5	13.0	7.5	....

	Mineral Spirits T.W.	V.M.&P. T.W.
Newark, N. J.	13	14.5
Baltimore, Md.	15.5	....
Washington, D. C.	15.5	....

Fuel Oils—T.W.	No. 1	No. 2	No. 3
Atlantic City, N. J.	10	9	9
Newark	10	9	9
Annapolis, Md.	...	...	...
Baltimore	9.8	9	9
Washington, D. C.	10.3	9.4	9.4
Norfolk, Va.	10	8.8	8.8
Petersburg	10.3	9	...
Richmond	10.3	9	9
Charlotte, N. C.	10.6	10.4	...
Hickory, N. C.	....	10	...
Raleigh	11.6	10.1	...
Charleston, S. C.	....	9	...
Columbia	....	10	...
Spartanburg	....	10.8	...

*Effective Aug. 5, '42 minimum retail resale price of 14.2c posted thru New Jersey.

Discounts:

Esso gasoline—to undivided dealers, 0.5c off dealer t.w.

Kerosine—1c off t.w. price for 25 gals. or more, under contract thru territory (Baltimore city contract not necessary) except no discount in state of New Jersey.

Naphthas—To buyers taking following quantities at one time: Newark, 2c per gal. on 200 gals. or more, less than 200 gals. 0.5c higher price; Baltimore, 2c off on 25 to 100 gals. and 3c on over 100 gals.; Washington, 2c off to contract buyers.

(N.B. Prices are Continental's "structural" prices. Prices do not reflect temporary reductions made to meet local competition.)

Notice

These prices include inspection fees on both gasoline and kerosine unless otherwise specified per gallon as follows:

Ala. 1/40c on gasoline, 1/2c on kerosine; Ark. 1/20c; Fl. 1/8c; Ill. 3/100c; Ind. 1/5c in lots of 25 bbls. or less, 2/25c in lots of more than 25 bbls.; Kans. 1/50c; La. 1/32c; Minn. 7/200c; Mis. 1/50c; Neb. 3/100c; Nev. gasoline 1/20c; N. C. 1/4c; N. Da. 1/20c; Okla. 2/25c; S. Car. 1/8c; S. Da. 1/20c; Tenn. 2/5c: and Wisc. 3/100c.

Kerosine inspection fees only: Iowa 3/50c; Mich. 1/5c per gal.

S. O. NEB.

	(*Regular Grade*) T.W.	Dealer	Gasoline Taxes	Kerosine T.W.
Omaha	11.4	9.6	6.5	10.1
McCook	12.0	10.1	6.5	10.5
Norfolk	11.9	10.4	6.5	10.6
North Platte	12.2	10.6	6.5	11
Scottsbluff	12.9	10.2	6.5	10.9

S. O. CAL.

Standard Gasoline (*Regular Grade*)
Flight Gasoline (*Third Grade*)

	Standard Posted Net Tank Truck	Standard Posted Retail	Flight Posted Net Tank Truck	Flight Posted Retail	Gasoline Taxes
San Francisco, Cal.	10	14	9	12	4.5
Los Angeles, Cal.	9.5	13.5	8.5	11.5	4.5
Fresno, Cal.	11	15	10	13	4.5
Phoenix, Ariz.	12	16	10	13	6.5
Reno, Nev.	12	16	11	14	5.5
Portland, Ore.	10.5	14.5	9.5	12.5	6.5
Seattle, Wash.	10.5	14.5	9.5	12.5	6.5
Spokane, Wash.	12.5	16.5	11.5	14.5	6.5
Tacoma, Wash.	10.5	14.5	9.5	12.5	6.5

Std. Aviation 73

	Posted Net Tank Truck	Gasoline Taxes	Kerosine Tank Truck
San Francisco, Cal.	12.5	4.5	11.5
Los Angeles, Cal.	12	4.5	10
Fresno, Cal.	13.5	4.5	12.5
Phoenix, Ariz.	14.5	6.5	12.5
Reno, Nev.	14.5	5.5	13.5
Portland, Ore.	13	6.5	13.5
Seattle, Wash.	13	6.5	13.5
Spokane, Wash.	16	6.5	16.5
Tacoma, Wash.	13	6.5	13.5

Resale & Commercial: T.C. deliveries 0.25c per gal. off posted net tank truck.

Commercial: Retail deliveries, and/or tank truck deliveries of less than 40 gals., 4c per gal. above posted net tank truck price for Standard Aviation and Standard Gasoline, and 3c per gal. above posted net tank truck for Flight Gasoline, except single deliveries of less than 40 gals. to Marine trade only, which are billed at posted net tank truck price.

TEXAS CO.

	Gasoline—Dealer T.W. Fire-Chief (*Regular*)	Indian (*3rd Grade*)	Gasoline Taxes
Dallas, Tex.	7.5	6.5	5.5
Ft. Worth, Tex.	7.5	6.5	5.5
Wichita Falls, Tex	8.5	7.5	5.5
Amarillo, Tex.	8.5	7.5	5.5
Tyler, Tex.	8.5	7.5	5.5
El Paso, Tex.	11	10.5	5.5
San Angelo, Tex.	8.5	7.5	5.5
Waco, Tex.	8.5*	7*	5.5
Austin, Tex.	8.5	7.5	5.5
Houston, Tex.	8.5	7.5	5.5
San Antonio, Tex.	8.5	7.5	5.5
Port Arthur, Tex.	8.5	7.5	5.5

*Less 1c temporary allowance to all dealers.

(Continued on next page)

Tank Wagon Prices—Continued

S. O. IND.

Red Crown (*Regular Grade*)
Blue Crown (*Third Grade*)
Red Dealer Prices

	Crown Cons. T.W.	Red Crown	Blue Crown	Gasoline Taxes	Kerosine T.W.
Chicago, Ill.	11.6	9.6	9.1	4.5	10.6
Decatur, Ill.	11.6	9.6	8.7	4.5	10.3
Joliet, Ill.	11.9	10.3	9.2	4.5	10.6
Peoria, Ill.	11.7	9.9	9.7	4.5	10.4
Indianapolis, Ind.	11.6	10.1	9.6	5.5	10.1
Evansville, Ind.	11.4	9.9	8.6	5.5	9.9
South Bend, Ind.	12	10.5	10	5.5	10.5
Detroit, Mich.	11.4	9.9	9.4	4.5	10
Grand Rapids, Mich.	11.4	9.9	9.4	4.5	9.9
Saginaw, Mich.	11.4	9.9	9.4	4.5	9.9
Green Bay, Wis.	12.2	10.7	10.2	5.5	10.9
Milwaukee, Wis.	12.1	10.6	10.1	5.5	10.8
La Crosse, Wis.	11.9	10.4	9.9	5.5	10.6
Minneapolis - St. Paul	11.9	10.4	9.9	5.5	10.6
Duluth, Minn.	12.2	10.7	10.2	5.5	10.9
Mankato, Minn.	11.9	10.4	9.9	5.5	10.6
Des Moines, Ia.	11.4	9.9	9.4	4.5	*10.1
Mason City, Ia.	11.7	10.2	9.7	4.5	*10.4
St. Louis, Mo.	11.0	9.5	9.3	*4.5	10.1
Kansas City, Mo.	11.0	9.5	8.6	*4.5	9.7
St. Joseph, Mo.	11.2	9.7	9.2	*4.5	9.9
Fargo, N. D.	12.9	11.4	10.9	5.5	11.6
Huron, S. D.	12.3	10.8	10.3	5.5	11
Wichita, Kans.	10.3	8.8	7.2	4.5	9.0

Stanavo Aviation 73 Octane
Withdrawn Jan. 1, 1944.

(Prices are base prices before discounts)

	Oleum Spirits	V.M.&P. Naphtha	Stanisol	*Taxes
Chicago	13.5	13.8	12.8	4.5
Detroit	15.8	15	16.3	4.5
K. C., Mo.	13.3	14.3	13.8	1.5
St. Louis, Mo.	13.7	14.7	13.2	1.5
Milwaukee	14.4	15.4	14.9	5.5
Minneap'ls	14.2	15.2	13.5	5.5

Fuel Oils T.W.
Chicago

	Standard Heater Oil
1-99 gals.	9.3
100-149 gals.	8.3
150 gals. & over	7.8

	Stanolex Furnace Oil
1-99 gals.	8.8
100-149 gals.	7.8
150-399 gals.	7.8
400 gals. & over	7.3

	Stanolex Fuel A
1-749 gals.	6.5
750 gals. & over	5.75

	Stanolex Fuel C
1-749 gals.	6.0
750 gals. & over	5.25

Other Points Indianapolis	Stanolex Furnace Oil
1-99 gals.	9.0
100 gals. & over	8.0
Detroit	
1-99 gals.	8.7
100 gals. & over	7.7
Milwaukee	
1-99 gals.	9.0
100 gals. & over	8.0
Minneapolis	
1-99 gals.	9.1
100 gals. & over	8.1
St. Louis	
1-99 gals.	8.4
100 gals. & over	7.4
Kansas City	
1-99 gals.	8.1
100 gals. & over	7.1

*Taxes: In gasoline tax column are included these city taxes—Kansas City, St. Joseph and St. Louis, 1c. Iowa kerosine prices are ex 3c state tax. In naphtha tax column are included 1.5c federal tax and state taxes.

State sales, occupation, consumer and use taxes to be added when applicable.

HUMBLE OIL

Humble Motor Fuel (*Regular Grade*)

	Thriftane Humble *Tank Wagon	Re-tail	(*Third Grade*) Thriftane *Tank Wagon	Gasoline Re-tail	Taxes
Dallas, Tex.	7.5	10.5	6.5	10.5	5.5
Ft. Worth, Tex	6.5	9.5	6	7.5	5.5
Houston, Tex.	8.5	12.5	7.5	10.5	5.5
San Ant., Tex.	8.5	12.5	7.5	10.5	5.5

	Kerosine *Tank Wagon	Retail
Dallas, Tex.	7	10
Ft. Worth, Tex.	7	11
Houston, Tex.	8	11
San Antonio, Tex.	7	10

	Tank Car
73 Oct. Aviation Gasoline	
FOB Baytown, Tex.	8.5

*To all classes of dealers & consumers.

S. O. OHIO

*Sohio X-70 Gasoline (*Regular Grade*)

	Consumer T.W.	**Reselers	Gasoline ‡S.S. Taxes	†Kerosine T.W.
Ohio, Statewide	12	10	13.5	5.5	9.3
Akron	12	9.5	12.5	5.5	9.3
Cincinnati	12	9.5	12.5	5.5	9.3
Cleveland	12	9.5	12.5	5.5	9.3
Columbus	12	9.5	12.5	5.5	9.3
Dayton	12	9.5	12.5	5.5	9.3
Marietta	12	9.5	12.5	5.5	9.3
Portsmouth	12	9.5	12.5	5.5	9.3
Toledo	12	9.5	12.5	5.5	9.3
Youngstown	12	9.5	12.5	5.5	9.3

Aviation Gasoline—Statewide

	Consumer Gasoline T.W.	Taxes
Sohio Aviation Gasoline clear Spec. AN-F-22	14.5	5.5
Esso Ethyl Aviation 73 Oct.	15.5	5.5
Esso Ethyl Aviation 80 Oct.	16.5	5.5
Esso Ethyl Aviation 87 Oct.	17.5	5.5
Esso Ethyl Aviation 91 Oct.	17.5	5.5
Esso Ethyl Aviation 100 Oct.	24.5	5.5

	†Naphtha—T.W. Statewide	Lucas County
S. R. Solvent	13.5	13.5
D. C. Naphtha	14.5	14.25
V.M.&P. Naphtha	14.5	14.25
Varnolene	14.5	14.25
Sohio Solvent	14.5	14.25

Fuel Oils—T.W.	No. 1	No. 2	No. 3	No. 4
Ohio, Statewide	8.3	8.3	7.8	*7.55

*Renown (third-grade) prices are same as X-70 unless otherwise noted.

**Except authorized agents.

†Kerosine prices are ex 1c state tax. Naphtha prices are ex 1.5c federal & 4c state tax.

‡Prices at company-operated stations.

††Statewide prices are subject to exceptions other than those shown.

Discounts:

Esso aviation—on contract to hangar operators and resellers, 2c off consumer t.w.

*For Cleveland area only.

Fuel oils—Statewide prices are for t.w. & drum deliveries of 50 gals. or more; prices for deliveries of less than 50 gals. are 0.5c higher. Cleveland Division assumed the state-wide fuel oil tank wagon prices on Nos. 1, 2 and 3 fuel oil, effective May 10. However the price of 7.55c per gallon and No. 4 fuel oil (full compartment hose dumps only) will remain as heretofore, in Cleveland Division.

Naphthas—to contract consumers off t.w. prices—Statewide: 300 to 999 gals., 0.5c; 1000 to 2499 gals., 0.75c; 2500 to 4999 gals., 1c; 5000 or more gals., 1.5c. Lucas County: Less than 50 gals., tank wagon price, 50 to 249 gals., 0.5c; 250 to 499 gals., 1c; 500 gals. or over, 1.5c.

Canada

PRICES OF IMPERIAL OIL, LTD.

Per Imperial Gallon, which is 1.2 U. S. Gallons

IMPERIAL OIL

3-Star Imperial Gasoline (*Regular Grade*)

	†Gasoline T.W.	*Gasoline Taxes	†Kerosine T.W.
Hamilton, Ont.	17.5	11	18
Toronto, Ont.	17.5	11	18
Brandon, Man.	21	10	23
Winnipeg, Man.	20.5	10	22.5
Regina, Sask.	18	10	20
Saskatoon, Sask.	20.8	10	22.8
Edmonton, Alta.	18.9	10	20.9
Calgary, Alta.	16	10	18
Vancouver, B. C.	15	10	24
Montreal, Que.	17	11	17.5
St. John, N. B.	16.5	13	19
Halifax, N. S.	16.5	13	19

*Includes 3c Federal, and Provincial taxes. To divided & undivided dealers.

Absorption Gasoline—No. 26 R.V.P.—$2.26.

ATLANTIC REFINING

Atlantic White Flash (*Regular Grade*)

	Commercial T.W.	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
Philadelphia, Pa.	10.2	10.7	5.5	12.25
Pittsburgh	10.7	11.2	5.5	12.6
Allentown	10.7	11.2	5.5	12.6
Erie	10.7	11.2	5.5	12.6
Scranton	10.7	11.2	5.5	12.6
Altoona	10.7	11.2	5.5	12.6
Emporium	10.7	11.2	5.5	12.6
Indiana	10.7	11.2	5.5	12.6
Uniontown	10.7	11.2	5.5	12.6
Harrisburg	10.7	11.2	5.5	12.6
Williamsport	10.7	11.2	5.5	12.6
Dover, Del.	....	11.2	5.5	12.6
Wilmington, Del.	....	10.7	5.5	12.1
Boston, Mass.	....	10.9	5.5	....
Springfield, Mass.	....	11.8	4.5	....
Worcester, Mass.	....	11.5	4.5	....
Fall River, Mass.	....	11	4.5	....
Hartford, Conn.	....	11.6	4.5	....
New Haven, Conn.	....	11	4.5	....
Providence, R. I.	....	11	4.5	....
Atlantic City, N. J.	....	10.7	4.5	10
Camden, N. J.	....	10.7	4.5	10
Trenton, N. J.	....	10.7	4.5	10
Annapolis, Md.	....	11.05	5.5	10.8
Baltimore, Md.	....	10.45	5.5	9.8
Hagerstown, Md.	....	11.55	5.5	10.8
Richmond, Va.	....	11.25	6.5	12.8
Wilmington, N. C.	....	11.55	7.5	11.9
Brunswick, Ga.	....	10.4	7.5	11.1
Jacksonville, Fla.	....	10.4	8.5	12.1

	Mineral Spirits T.W.†	V.M.&P. T.W.†
Philadelphia, Pa.	11	12.5
Lancaster, Pa.	12	13.5
Pittsburgh, Pa.	12.5	13.5

Fuel Oils—T.W.

	1	2	3	5	6*
Phila., Pa.	10.1	9	9	5.76	5.04*
Allentown, Pa.	10.6	9.3	9.3	....	....
Wilmington, Del.	10.1	9	9	....	....
Springfield, Mass.	10.2	9.4	9.4	....	....
Worcester, Mass.	10.2	9.3	9.3	....	....
Hartford, Conn.	10.5	9.2	9.2	....	....

‡Does not include 1c Georgia kerosine tax.

†Mineral Spirits prices also apply to Stoddard Solvent; V.M.&P. prices also apply to Light Cleaners Naphtha.
Discounts:

Gasoline—to undivided dealers, 0.5c off dealer t.w. except Georgia & Florida dealer t.w. and undivided dealer t.w. prices are same.

Kerosine—Thru Penna. & Delaware, 2c off t.w. price on t.w. deliveries of 25 gals. or more at one time.

*Residual fuel 13.0-15.9 gravity effective 10/17/43.

S. O. KY.

Crown Gasoline (*Regular*)
Standard (*Third Grade*)

	†Net Crown	Dealer Standard	Gasoline Taxes	Kerosine T.W.
Covington, Ky.	9.5	...	6.5	9.3
Lexington, Ky.	10.5	...	6.5	9.3
Louisville, Ky.	10	...	6.5	8.8
Paducah, Ky.	10	....	6.5	8.8
Jackson, Miss.	10	....	7.5	*9
Vicksburg, Miss.	9.5	...	7.5	*8.5
Birmingham, Ala.	10	...	*8.5	9
Mobile, Ala.	9	...	*9.5	9.5
Montgomery, Ala.	10	...	*9.5	10
Atlanta, Ga.	11.4	....	7.5	*12.1
Augusta, Ga.	11.4	...	7.5	*11.6
Macon, Ga.	11.4	...	7.5	12.1
Savannah, Ga.	10.4	....	7.5	11.1
Jacksonville, Fla.	10.4	...	8.5	10.1
Miami, Fla.	10.4	...	8.5	10.1
Pensacola, Fla.	9	8	*9.5	8
Tampa, Fla.	10.4	...	8.5	10.1

*Taxes: In tax column are included these city and county gasoline taxes: Mobile, 2c city; Birmingham, 1c city; Montgomery, 1c city and 1c county; Pensacola, 1c city. Georgia and Montgomery, Ala. have 1c kerosine tax, Mississippi 0.5c, not included in above prices.
†Consumer t.w. prices are same as net dealer prices.

S. O. LA.

Esso Gasoline (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
New Orleans, La.	8.75	9.25	8.5	*9
Baton Rouge, La.	8.75	9.25	8.5	*9.5
Alexandria, La.	8.75	9.25	8.5	*9.5
Lafayette, La.	9	9.5	8.5	*9
Lake Charles, La.	9	9.5	8.5	*11
Shreveport, La.	8.5	9	8.5	*8
Knoxville, Tenn.	10.5	11	8.5	12.5
Memphis, Tenn.	8.90	9.40	8.5	10.5
Chattanooga, Tenn.	10.5	11	8.5	11
Nashville, Tenn.	10.5	11	8.5	10
Bristol, Tenn.	10.95	11.45	8.5	13.1
Little Rock, Ark.	9.5	10	8	10

*Louisiana kerosine prices are ex 1c state tax
Discounts:

Esso Gasoline—To undivided dealers, 0.5c off dealer t.w.

(Continued on next page)

Seaboard Export Coastwise Prices

Atlantic Coast (Prices are of refiners, FOB their refineries & their tanker terminals, & of tanker terminal operators FOB their terminals)—Prices in Effect July 31.

MOTOR GASOLINE

District	72 Oct. (ASTM)	Housebrand (ASTM)	KEROSINE and/or NO. 1 FUEL
N. Y. Harb.	Not made	9.2 – 9.4	7.1
N. Y. Harb., barges	"	9.1 – 9.3	7
Albany	"	9.3 – 9.4	7.3
Philadelphia	"	9.2	7.2
Baltimore	"	8.95	7.2
Norfolk	"	8.7 – 8.95	7.1
Wilmington, N. C.	"	8.7 – 8.75	7.05
Charleston	"	8.7 – 8.8	7.2
Savannah	"	8.25 – 8.4	7.05
Jacksonville	"	8.27 – 8.275	7.05 (2)
Miami	"	8.27-8.275 (2)	7.05
Tampa	"	8.27 – 8.4	7.05
Pensacola	"	7 –7.2 (1)	4.8 (1)
Mobile	"	6.62 – 7.2	4.75 (2)
New Orleans	"	6.125– 6.375	4.25 – 4.75
Portland	"	9.5 – 9.65	7.3
Boston	"	9.4	7.2
Providence	"	9.4	7.2

(a) This price is for straight-run low pour test No. 5 fuel.

Pacific Export *In Ship's Bunkers, or deep tank lots:*

Prices in Effect	July 31	July 24
Diesel Fuel, Pac. Spec. 200	$1.45	$1.45
Grade C fuel, Pac. Spec. 400	$1.10	$1.10

FUEL OILS

	No. 2	No. 3	No. 5	No. 6
N. Y. Harbor	6.7	6.7	$1.95-2.01(1&a)	$1.65 –$2.07
Albany	6.6	6.6	....	....
Philadelphia	6.8	6.8 (2)	....	$1.85–$2.27 (1)
Baltimore	6.7	6.7	$1.98	$1.65 –$2.07
Norfolk	6.7	6.7	....	$1.65 –$2.07
Charleston	6.7	6.7 (1)	....	$1.65–$2.07 (2)
Savannah	6.7	....	....	....
Jacksonville	6.7 (2)	....	....	$1.60–$2.02 (2)
Tampa	6.25 (1)	....	....	$1.60–$2.02 (1)
New Orleans	6.25	....	....	$1.60–$2.02 (1)
Portland	6.25 (1)	....	....	....
Boston	6.25	....	....	$1.50–$1.92 (2)
Providence	....	....	....	....
	....	....	....	....
	3.75 (2)	....	$1.27 (1)	$0.85–$1.27 (2)
	6.8	6.8 (2)	....	$1.65–$2.07 (1)
	6 7	6.7 (2)	$1.95–$2.07 (1)	$1.65 –$2.07
	6.7	6.7 (2)	$1.90 (1)	$1.65 –$2.07

Tank Wagon Prices (Continued)

SOCONY VACUUM

	Socony Mobilgas (*Regular Grade*) Com. Cons. T.W.	Indiv. Dlr. T.W.	Gasoline Taxes
New York City			
Manhattan & Bronx	10.1	10.6	*5.5
Kings & Queens	10.1	10.6	*5.5
Richmond	9.7	10 2	*5.5
Albany, N. Y.	9.9	10.4	5.5
Binghamton, N. Y.	11	11.5	5.5
Buffalo	10.2	10.7	5.5
Jamestown, N. Y.	10.4	10.9	5.5
Mt. Vernon, N. Y.	10.1	10.6	5.5
Plattsburg, N. Y.	11	11.5	5.5
Rochester, N. Y.	10.8	11.3	5.5
Syracuse, N. Y.	10.5	11	5.5
Bridgeport, Conn.	10	10.5	4.5
Danbury, Conn.	10.5	11	4.5
Hartford, Conn.	10.6	11.1	4.5
New Haven, Conn.	10	10.5	4.5
Bangor, Me.	10.7	11.2	5.5
Portland, Me.	10.3	10.8	5.5
Boston, Mass.	9.9	10.4	4.5
Concord, N. H.	11.4	11.9	5.5
Lancaster, N. H.	12	12.5	5.5
Manchester, N. H.	11.3	11.8	5.5
Providence, R. I.	10	10.5	4.5
Burlington, Vt.	10.9	11.4	5.5
Rutland, Vt.	11	11.5	5.5

	Mineral Spirits T.W.	V.M.&P. T.W.
Buffalo, N. Y.	12.4	13.6
New York City	11	12
Rochester, N. Y.	13.2	14.4
Syracuse, N. Y.	14	....
Boston, Mass.	12	13
Bridgeport, Conn.	†16.3	†17.3
Hartford, Conn.	†16.3	†17.3
Providence, R. I.	13	14

	Kerosine Yard	Kerosine T.W.	Mobilfuel Diesel T.C.	Mobilfuel Diesel T.W.	Mobilheat Fuel Yard	Mobilheat Fuel T.W.
New York:						
Manhat'n & Bronx	7.5	10.3	...	9.3	7.1	9
Kings & Queens	7.5	10.3	...	9.3	7.1	9
Richmond	7.5	10.3	...	...	7.1	9.0
Albany	7.5	9.8	7	9.3	7	9
Binghamton	8.9	11.2	...	10.7	8.4	10.2
Buffalo	8.6	10.9	8	10.3	8.2	10
Jamestown	8.7	11	...	10.6	8.3	10
Mt. Vernon	7.6	10.3	...	9.4	7.2	9
Plattsburg	8.1	10.4	...	9.9	7.6	9.4
Rochester	8.7	11	7.9	10.2	7.9	9.7
Syracuse	8.5	10.8	7.8	10.1	7.8	9.6
Conn.:						
Bridgeport	7.8	10.3	...	....	7.4	9.0
Danbury	8.2	10.8	...	....	7.8	8.8
Hartford	8.0	10.5	...	9.5	7.4	9.2
New Haven	7.5	10.3	...	9.3	7.1	9.0
Maine:						
Bangor	7.9	10.2	7.4	9.7	7.4	9.1
Portland	7.5	10.2	7	9.3	7	9
Mass.:						
Boston	7.8	10.6	6.9	9.2	7.1	9
N. H.:						
Concord	8.4	10.7	...	....	8.2	10
Lancaster	9.5	11.8	...	....	9.2	11
Manchester	8.5	11.1	...	....	7.9	9.7
R. I.:						
Providence	7.6	9.9	6.9	9.2	7.1	8.9
Vermont:						
Burlington	8.1	10.4	7.5	9.8	7.5	9.2
Rutland	8.3	10.6	...	10	7.7	9.5

*Does not include 1% city sales tax applicable to price of gasoline (ex tax).

†In steel barrels.

Discounts: Diesel—On t.w. deliveries, 0.5c for at least 400 gals.; 1c for full tank truck.

	Bunker C Fuel Ships' bunkers (Ex Lighterage)	Diesel Oil Ships' bunkers (Ex Lighterage)	Diesel Oil Shore Plants	Gas House Gas Oil 28-34 Gravity
N. Y. Harbor	$1.65–$2.07 (b)	$2.78	6.7–6.8 (2)	6.8 (2)
Albany	$1.85 –$2.09(1)	$2.98 (1)	7 (1)	7 (1)
Philadelphia	$1.65 –$2.07	$2.78	....	....
Baltimore	$1.65 –$1.77	$2.78	6.7 (1)	6.7 (1)
Norfolk	$1.65 –$2.07	$2.78	6.7 (1)	6.7 (1)
Charleston	$1.60 –$2.02	$2.78 (2)	6.7 (1)	6.7 (1)
Savannah	$1.60-1.72(1)	$2.62 (1)	....	....
Jacksonville	$1.60–$2.02 (2)	$2.62 (2)	....	....
Tampa	$1.50 –$1.92	$2.62	....	....
New Orleans	$0.85–$1.27	$1.65 (1)	4 (1)	....
Portland	$1.65–$1.77	$2.86 (2)	7 (1)	6.9 (1)
Boston	$1.65–$1.77	$2.78	6.7 (2)	6.8 (2)
Providence	$1.65 –$2.07	$2.78 (2)	6.9 (1)	6.8 (1)

Residual fuel prices generally vary with A.P.I. specifications from range low for 9.9 & below degrees to range high for 25.0 & above.

Bunker "C" when from Navy storage at New York and Norfolk to W.S.A. ships .05c discount.

(b) Range represents grav. from 9.9 & up. OPA ceiling for 13-15 grav. $1.77.

Gulf Coast

Prices in Effect July 31

MOTOR GASOLINE	New Orleans & Lower Mississippi to Baton Rouge Tank Cars	New Orleans & Lower Mississippi to Baton Rouge Barge	Texas Gulf Coast South of New Orleans Tank Cars	Texas Gulf Coast South of New Orleans Barges	CARGOES Domestic & Export From all Gulf Ports
Leaded (oct. by ASTM)					
76 oct.	6.75	6.5	6.5 –6.75	6.75	6.75
Housebrand	6.125– 6.375	5.75	5.75–6.5(a)	5.75	5.75
63-65 oct.	....	....	....	....	....
Unleaded 70 oct.	....	....	....	....	5.75
67-68 oct.	....	....	....	....	5.5
65 oct.	....	....	....	....	5.25
60 oct.	....	....	....	....	5
KEROSINE & LIGHT FUELS					
41-43 w.w. kero.	4.125–4.25	4.125	4.125– 4.25	4.125	4.125
42-44 w.w. kero.	....	....	4.125	4.125	4.125
No. 2 fuel oil	3.75	3.75	3.75 – 4	3.75	3.75
DIESEL & GAS OILS					
(In diesel index No.)					
Below 43 di.	....	....	....	....	....
43-47 di.	....	....	....	....	4
48-52 di.	4	4	4	....	4
53-57 di.	4.125	4.125	4.125	4.125	4.125
58 and above	4.25	4.25	4.25	....	4.25

(a) 5.75c for Dist. 1 and 6.5c for other districts.

HEAVY FUELS & BUNKER OILS In Cargoes (At all Gulf Ports) Heavy Diesels	In Ship's Bunkers (Ex-lighterage)
Below 28 API Grav.	$1.35
28 & above API Grav.	$1.65
Bunker C Oil... $0.85–$1.27	$0.85–$1.27

Above products in Truck Transports of 2,400 gal. and over ½c above Tank Car Prices.

NOTE—Prices for heavy fuels vary within the range given above according to gravity from 9.9 B grav. and below to 25 B and above.

Mid-Continent Lubes

(At Gulf; in packages, FAS.; in bulk, FOB terminals)

Prices in Effect July 31

	Steel Drums	Bulk
200 Vis. D 210 brt. stock	....	....
150 vis. D 210 brt. stock 0-10 p.p.	32.65(1&A)	24.8 (1)
10-25 p.p.	....	....
100 vis. D 210 brt. stock 0-10 p.p.	....	....
10-25 p.p.	....	....
200 vis. No. 3 col. neutral: 0-10 p.p.	....	....

(A) FAS at New Orleans

Wax

(Melting points are AMP, 3° higher than EMP. Prices are FOB refinery and do not include bag, freight or export differentials).

Prices In Effect July 31

Crude Scale	New Orleans Export	N. Y. Domestic	N. Y. Export
124-6 Yellow	4.25(1)	....	4.25(1)
122-4 White.	....	4.25(2)	4.25(2)
124-6 White.	4.25(1)	4.25	4.25
Fully Refined:			
123-5	5.2(1)	5.2(2)	5.2(1)
125-7	5.2(1)	5.2(2)	5.2(1)
128-30	5.6(1)	5.6	5.6(1)
130-32	5.85(1)	5.85(2)	5.85(1)
133-5	6.15(1)	6.15	6.15(1)
135-7	6.4(1)	6.4(1)	6.4(1)

Naphtha

Prices in Effect July 31

	V.M.&P. Naphtha	Mineral Spirits
New York Harbor	11 (2)	10
Philadelphia dist.	11 (2)	10
Baltimore	10.5 (2)	9.5
Boston	11.5 (2)	10.5
Providence	11.5 (1)	10.5 (2)

CLASSIFIED

For Sale

SEVEN—Mack Tractor Trucks. If interested write for details. Lancaster Motor Truck Service, 459 Juliette Ave., Lancaster, Penna.

FOR SALE: 1941 G.M.C. Tank Truck, 720 gallon capacity, three compartments, hose reel and hose auto stop, meter. Harbor Fuel Company, Inc., Glen Cove, L. I., N. Y.

AVAILABLE 600 cases Bottled motor oil packed 20/1 quart bottles to case. All grades SAE No. 10-20-30-40. Attractive labeled package. Carload or LCL 45c per gallon, tax paid, F.O.B. Detroit, Mich. Box No. 438.

FOR SALE

3½ Ton—1940 Autocar cab-over-engine Tractor and 4500 gallon Butler semi tank trailer—3 compartment.

Oil Carriers Co.,
10260 Gratiot Ave.,
Detroit 13, Mich.

1 TRAILER TANK, four compartment 1955 gallon capacity, with barrel rack on each side. 1½ Ton Dodge truck 1941 model with cab. Good rubber, truck operating every day. Picture sent on request. Bargain.

H. D. Todd
P. O. Box 1524 Mobile 9, Ala.

110 USED STEEL TANKS, open and closed tops, 280 to 1,000,000 gals. 2" and 3" Blackmer pumps. 2" and 3" Brodie and other meters. 2" and 3" valves, fittings and pipes. All in A-1 condition. Immediate delivery. No priority.

Write, Wire, or Phone
Empire Equipment Corporation
608 Empire Bldg. Cleveland 14, Ohio

GRADE III RECAPPED AND USED TIRES. 25% discount off O.P.A. ceiling price in lots less than 100. 30% off for 100 or more. Full stock of popular and obsolete sizes. A 25% deposit, balance C.O.D. or SD/BL with each order.

Lorain Avenue Tire Co.,
7982 Lorain Ave., Cleveland 2, Ohio,
Phone: Woodbine 9745

TANK CARS

15—8000 Gal & 7600 Gal. Cap.
STORAGE TANKS
3—8 Ft. x 40 Ft. Horizontal Cylindrical.
5—7000 Gal. & 8000 Gal. R.R. Car Tanks.

R. C. STANHOPE, INC.,
60 East 42nd St., New York 17, N. Y.

BARRELING & DRUMMING

Complete Plant and
Railroad Facilities For
All Petroleum Products

BALTIMORE HARBOR DISTRICT

Inquiries Solicited

ARROW OIL COMPANY
Baltimore 3, Md.

For Lease

225,000 GALLON
Gasoline—Fuel Bulk Plant
Office—Garage
615 E. Greendale
DETROIT
Wolverine Oil Corp.,
910 So. Cedar, Lansing, Mich.

For Sale or Lease

FOR SALE OR LEASE old established gas, oil, tire business, bulk plant in Central Ohio with large farming territory. 98% of business is to the farming trade. Capacity of plant storage 200,000 gallons. Interested parties will be furnished full information upon request. National Petroleum News, Box No. 437.

Positions Wanted

COMPETENT MAN with wide experience in grease making and lube oils, wishes to make connection with major or independent oil company. Box No. 424.

TAX MAN: major company interested in making change account salary only. Experience all phases taxation southern states, legal education. Draft exempt. Box No. 434.

AS BULK PLANT OPERATOR—36 years old, ten years as manager of commission agency, experience includes all phases of operations. Can furnish references. Desires permanent job with an established company in south. Box No. 436.

Business Opportunities

RELIABLE YOUNG ORGANIZATION, principals well known in oil industry for integrity, will finance, aid in development of, and market patented or non-patented product, device or idea, related or allied to the Petroleum and Chemical Industry. Replies will be kept strictly confidential. References exchanged if desired. Box No. 430.

SOLVENT REFINING PATENTS
FOR SALE OR LICENSE

Reputable nationwide chemical company will license or sell direct three solvent patents. Vickery — 2,149,752, Volck—2,076,105 and Volck—2,047,-755. Additional information may be obtained by writing—

Box No. 422.

Professional Services

ANTI-KNOCK VALUES
DETERMINATORS
The Gray Industrial Laboratories
Chemists and Engineers
Specialists on Petroleum Products
961-976 Frelinghuysen Ave.,
NEWARK, N. J.
Telephone Bigelow 3-4020

ACCURATE LABORATORY TESTS
GASOLINE OIL
Standard Methods Employed
Octane Ratings by A.S.T.M. CFR Unit
THE DETROIT TESTING LABORATORY
554 Bagley Avenue, Detroit 26, Mich.

Wanted to Buy

WANTED: One or two 5000 barrel storage tanks. In good shape. Box No. 433, c/o National Petroleum News.

WANTED: 4,000-4,400 gallon Semi-Trailer Transport. Give make, description and general condition. Box No. 427.

WANTED: Vacuum Lubricating Plant, 100 to 500 bbls. capacity. Give full description including age, condition, location, and best cash price. Box No. 431, National Petroleum News, Cleveland, Ohio.

LARGE RETAIL OIL CONCERN located in Baltimore, Maryland. desires capable man to manage and handle sales, installation and service of heavy oil burning equipment. Permanent and attractive position for right person. Box No. 429.

Situations Open

Mechanical Draftsman, familiar with designing gasoline and oil storage tanks and refinery equipment. Benson Manufacturing Co., Kansas City 1, Missouri.

TANK AND PLATE
SHOP SUPERINTENDENT

wanted for modern plant working about 300 employees. Must be able successfully handle men, cost conscious, and capable producing quality. Give full particulars, references and availability first letter. Good opportunity with old established well rated company.

Box No. 432

MAINTENANCE ENGINEER

Large independent Philadelphia oil compounder, blender and canner offers permanent position to plant engineer. Should be familiar with plant lay-out, canning operations, materials handling. Man with training and experience in other industrial organizations acceptable. In reply state experience, education, age, marital status, draft classification and salary expected, include small snapshot (not returnable). Replies strictly confidential. Applicants now employed at highest skill in war industries not solicited.

Box No. 418

National Petroleum News, Cleveland, O.

DESIGNERS
DRAFTSMEN
AND
SQUAD LEADERS

For Process Piping on Oil Refineries.

Applications solicited from men not now employed in essential work or those completing essential work who have Statements of Availability.

ARTHUR G. McKEE & COMPANY
2300 Chester Avenue
Cleveland, Ohio

CLASSIFIED

Situations Open

SITUATION OPEN

An excellent opening is available with a medium-sized completely integrated oil company operating in the Central States.

The man must have an engineering background and be competent to supervise truck and transport operations as well as the building and repair of service stations. Write immediately.

Box No. 435

FOREIGN EMPLOYMENT

ARABIAN AMERICAN OIL COMPANY

GRADUATE CHEMICAL ENGINEERS FOR PETROLEUM REFINERY AS WELL AS OTHER HIGHLY QUALIFIED TECHNICAL REFINERY AND OILFIELD PERSONNEL required for Arabian American Oil Company's operation in Saudi Arabia. Engineers experienced in petroleum refinery design and operations desirable but not essential. Extensive training on refinery equipment will be provided before leaving the United States. Employment offers splendid opportunities for advancement and post-war security. Good working conditions, hospital and medical care, liberal benefit plans and vacation privileges in the United States. If genuinely interested in a foreign assignment, please send full information covering experience, references, transcript of college record, draft and availability status to our Relations Department, No. 200 Bush Street, San Francisco 4, California.

Classified Rates

"For Sale," "Wanted to Buy," "Help Wanted," "Business Opportunities," "Miscellaneous" classifications, set in type this size without border—15 cents a word. Minimum charge, $4.00 per insertion.

"Position Wanted"—10 cents a word. Minimum charge $1.50 per insertion.

Advertisements set in special type or with border—$5.00 per column inch.

Copy must reach us not later than Saturday preceding date of issue.

All classified advertisements are payable in advance.

No agency commission or cash discounts on classified Advertisements.

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Equipment Personals

H. I. ("Hi") Beardsley, who has a reputation of knowing nearly everybody in the oil and utility business, particularly those having to do with equipment, has decided to take it easy after 32 years of doing the exact opposite.

Mr. Beardsley who has been an executive in the sales department of Pittsburgh Equitable Meter Co. since July 1, 1912, for many years was a "drummer" in the New York and New England territories for the old Pittsburgh Meter Co., predecessor to the present organization. He was later district manager in the Chicago territory, going from that to head the newly established gasoline and oil meter division in 1930. Equitable credits him as being largely responsible for this division growing to a dominant place in the company's business.

Even though Mr. Beardsley has announced his intentions of getting away from active business, for the present he will remain active in company affairs and lend his assistance to H. D. Leisenring, who will succeed him.

Pittsburgh Equitable Meter Co. has announced that Mr. Leisenring has been appointed manager of the oil meter sales. He is an engineering graduate of Lafayette College. He is well known in the oil industry gained through 10 years of exclusive work with the oil companies of the Midwest. He formerly had charge of this branch in the Chicago territory. His headquarters will be at the company's main office in Pittsburgh.

* * *

Harvey W. Blankenship, former advertising manager of the Graver Tank & Mfg. Co., became sales promotion manager, Industrial Division, S. C. Johnson & Son, Inc., Racine, Wis. on August 1. Mr. Blankenship's successor at Graver will be **Hugh M. Kanagy.**

* * *

Norman W. Stirling, formerly of the M. W. Kellogg Co., has been appointed manager of sales for Whitlock Manufacturing Co., Hartford, Conn., manufacturer of heat transfer equipment. Active in the heat transfer field, Mr. Stirling has recently been associated with the War Production Board on the heat exchanger advisory committee.

* * *

Several additions have been made to Phillips Pump and Tank Co., Cincinnati. They include **M. W. Ward**, works manager; **N. C. Heyns**, Comptroller, and **W. M. Templin**, Chief Engineer.

* * *

Jones & Laughlin Steel Corporation announces the following changes in its organization, effective July 27, 1944:

Lewis M. Parsons has resigned as a Director and a member of the Executive Committee, and as Vice President in Charge of Sales, of the Corporation.

Adam J. Hazlett, General Manager of Sales, has been elected Vice President in Charge of Sales of the Corporation.

John W. Reavis, a member of the law firm of Jones, Day, Cockley and Reavis, of Cleveland, has been elected a Director of the Corporation.

* * *

R. L. (Dick) White, recently of Washington, has re-established sales offices for the Franks Manufacturing Corp. of Tulsa in Fort Worth.

Coming Meetings

SEPTEMBER

American Chemical Society, New York City, Sept. 11-15.

Empire State Petroleum Assn., Inc., fall meeting, Hotel Commodore, New York City, Sept. 20-21.

National Petroleum Assn., Atlantic City, Sept. 20-22.

Michigan Petroleum Assn., Park Place Hotel, Traverse City, Sept. 26-27.

OCTOBER

American Assn. of Oil Well Drilling Contractors, annual meeting, Ft. Worth, Oct. 3-4.

Indiana Independent Petroleum Assn., fall meeting, Indianapolis, Oct. 11-12.

I.P.A.A. Director's Meeting, Dallas, Oct. 9-11.

Ohio Petroleum Marketers Assn., Deshler-Wallick Hotel, Columbus, O., Oct. 25-26.

NOVEMBER

South Dakota Independent Oil Men's Assn., Mitchell, S. D., Nov. 27-28.

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ABOUT OIL PEOPLE

D. E. (Pete) White, assistant to the district manager of the Tide Water Associated Oil Co. for the past 15 years, has been advanced to sales supervisor for the Utah-Idaho marketing division and will make his headquarters in Salt Lake City. Mr. White started with the oil industry in 1923 as a service station attendant for Tide Water at Fresno. About 80 of his friends paid him tribute at a farewell dinner in Los Angeles recently.

W. L. Funke, for 19 years associated with Tide Water marketing department in southern California and Arizona, has been promoted to sales agent at Oxnard. **John B. Davenport,** who has been agency supervisor at Riverside, succeeds Mr. Funke in Phoenix. **C. E. John** is promoted from marine salesman at San Pedro to agency supervisor 'B' at Riverside.

° ° °

W. G. Fountain, president of Fountain Oil Co., Richfield distributors, was recently elected mayor of Carolina Beach, N. C.

° ° °

Mr. Willien

Leon J. Willien, who has presented and published more than a score of technical papers of interest to oil technologists, has been appointed associate director of the Institute of Gas Technology at Illinois Institute of Technology.

Mr. Willien has been associated with the Public Utility Engineering and Service Corp., Chicago, as a gas engineer since 1937. He is author of a chapter on "Oil Gas" in "The Science of Petroleum," published by the Oxford University Press, Oxford, England.

° ° °

The Signal Oil and Gas Co. of Los Angeles has opened Mid-Continental offices in Fort Worth, Texas. The office will be in charge of **H. F. Vogel,** who will handle all operations east of the Rockies.

° ° °

Charles R. Wheeler, veteran of World War II, has been named field service representative of the Pennsylvania Grade Crude Oil Assn. with headquarters in Chicago, according to **W. C. Wenzel,** executive manager of the association. Mr. Wheeler, a second lieutenant in the national guard, entered service in February in 1941, became a captain in a tank destroyer battalion in Africa, and was honorably discharged in January 1944, after receiving wounds when a mine exploded at Sidi Bou Zid, Africa. Mr. Wheeler, formerly associated with National Transit Pump & Machine Co. of Oil City, saw action also at Kasserine Pass, El Guettar, and Maknassy.

° ° °

Pierre L. Lacombe, assistant vice president of Tide Water Associated Oil Co., died recently in San Francisco after a brief illness. Mr. Lacombe had been with Tide Water for 26 years. Two sons, Sergt. John A., and Lieut. Peter L., are in the Army.

° ° °

Ashland Oil and Refining Co. has promoted **Robert L. Gray** to marine superintendent. He will have charge of river transportation operations, including the personnel of boats, barges, and the river repair terminal at Catlettsburg. **Kenneth Nicholson** has been appointed marine maintenance superintendent in charge of repair work on all marine equipment and will assist Mr. Gray. Both men will work under the transportation manager, **M. C. Dupree. William E. Glover** has been named assistant to the transportation manager.

° ° °

R. D. (Bob) Hillis, Fleet Wing Corp., Cleveland, is "coming along fine" after surgical treatment at the Mayo Clinic in Rochester, Minn.

° ° °

Charles B. Carpenter, senior petroleum engineer of the U. S. Bureau of Mines in Dallas, was recently guest speaker before the Petroleum Engineers' Club of Fort Worth on the subject: "Conservation of Oil and Gas Underground."

° ° °

Bob Siddall, scout for the Atlantic Refining Co. at Midland, Tex., has been transferred to San Antonio, and his place in the West Texas office will be taken by **David Beck** of Amarillo. **Leo Walraven** of the drafting department has been transferred from Atlantic's Dallas office to Midland.

° ° °

Dr. Paul Gries has left the faculty of the South Dakota School of Mines to join the Magnolia Petroleum Co.'s Permian Basin district geological office in Midland, Texas.

° ° °

July 28th marked the 16th anniversary of **H. E. Armitage's** association with Frontier Refining Company's president, **M. H. Robineau.** Mr. Armitage, Frontier's vice president, started work in 1928 with the Western Nebraska Oil Co., Sydney, Neb., as a general utility man. He has been Mr. Robineau's right hand man ever since.

Oil Ladies

Get your contributions for the next Lazybench. Candy for you or cigarettes for your service friend for all published. Address Lazybench Editor, 5th Floor, Penton Bldg., Cleveland 13, O.

° ° °

Busy, congenial, conscientious **John Dozier,** manager for PAW's zone 4, Charlotte, N. C., will be taking it easy, at the doctor's direction, for the next several weeks. Mr. Dozier was taken suddenly ill while at his desk in Charlotte.

° ° °

Albert E. Pierce, who has been general manager of production for Mid-Continent Petroleum Corp. since August, 1943, was elected vice president in charge of production on July 28, 1944.

Mr. Pierce has been an employe of Mid-Continent since 1920 and his elevation with the company brought forth an expression of praise from **President Jacob France** who announced the promotion.

° ° °

L. R. Goldsmith, PAW chief, technical section, refining division in Washington, resigned on July 28, and returned to his native haunts with Shell Oil Co. in San Francisco. He joined the PAW organization in November, 1942.

° ° °

Dr. M. N. Newquist, medical director of The Texas Co., was recently elected president of the American Association of Industrial Physicians and Surgeons. Dr. Newquist became Medical Director of The Texas Co. in 1939. He served in the infantry in World War I, and practiced general medicine in Nebraska, his native state, for several years.

° ° °

George A. Weaver, geologist with the Pure Oil Co. in Fort Worth, has been transferred to Tyler, Tex., as East Texas district geologist.

° ° °

"Youngster", W. E. (Pop) Rice is the newly appointed manager in charge of retail credits for the Cleveland region of Cities Service Oil Co. "Pop" start-

ed out during the Spanish American war as a credit man, and retired in 1936. Becoming tired of the "old rocking chair", he answered a Cities Service want ad for employes. Now he is happily doing his bit in the war effort by releasing a man for the service.

° ° °

The Bishop Oil Co., a California exploration company, has opened offices in Midland, Texas, with **J. L. McAdams** in charge.

° ° °

Lain Dunagin, Topeka, president of Kansas Oil Men's Assn. sold his Dunagin Oil Co. jobbing business to Berry Oil Co. effective July 1, and is retiring for a rest of several months. He will continue his work as president of the state association, however, he said.

° ° °

Wilson L. Henry, Valvoline representative in the Chicago area for many years, left last week end for Washington where he joins the United Nations Relief and Rehabilitation Service.

° ° °

New district land man for the American Republics Corp. in San Antonio is **C. O. (Collie) Faulk,** who moved there from Midland, Tex., where he had been with Magnolia Petroleum Co.

° ° °

Oil gals get around, too. Recently a Cleveland columnist spotted 47 Cities Service-Doherty-Girls'-Sorority members at Monaco's, one of Cleveland's bright spots, celebrating something or another.

° ° °

Sherril Williams, Olney, Ill., oil scout for Illinois, Indiana and Kentucky, has been elected president of the Kentucky oil scouts, and vice president of the Indiana scouts.

° ° °

Bette, daughter of **Prof. Clark F. Barb,** head of the petroleum department at the Colorado School of Mines, and **Mrs. Barb** is a Women's Reserve Marine "boot" at Camp Lejeunne, N. C. After attending the University of Colorado, Miss Barb was a welder in Los Angeles before donning a uniform.

° ° °

Carl M. Ringbom, Shell Development Company, now serving in an air photographic squadron, has been officially commended by the Navy "for extensive experimental work in connection with the processing of aerial color film." His commendation reads:

"You have shown great initiative and ingenuity in devising equipment and meticulous effort in recording the results of your experiments. The report which you submitted was thorough and very informative. The report was forwarded to the Navy Department and comments of a highly commendable nature were received. Your report will be of great value in furthering the development of aerial color film."

LAZY BENCH

Wild Irish Prose

Mrs. O'Shaughnessy upon meeting her neighbor, Mrs. O'Brien, over the backyard fence, greeted her in the usual manner and then inquired about her son Patrick.

"Sure I don't know what I'm going to do about my Patty I'm that worried. In his letter he tells me he is running around with a Jeep."

"Worried are you? And why? A Jeep is nothing but one of them little jumping automobiles."

"Oh, glory be, and all the time I thought it was a female Jap."

HB—East Chicago, Ind.

° ° °

Moonshine

Starkle, starkle, little twink,
Who the heck you are, I think,
Though I'm under the afleunce of inkohol,
No twinkle peep I am,
I don't know who's me yet,
But the drunker I sit here,
The longer I get.

KC—Lawrence, Kans.

° ° °

Diagnosis

Doc: You have acute appendicitis.
Wac: Listen, I came her to be examined, not admired.

—Lonesome Ruth, Flying Red Horse gal.

° ° °

Appetizer

"Bread is the staff of life, but that is no reason why the life of our staff should be one continual loaf" was the terse note recently appearing on an oil company's bulletin board.

—Helen of Troy (Ohio)

° ° °

That's Tellin' 'im

A sauntering rookie from Alabama encountered a brisk second lieutenant. "Mawnin'," drawled the rookie pleasantly.

The outraged officer launched a stinging lecture on military courtesy, with emphasis on saluting.

"Lawdamighty," said the rookie, "if I'da knowed you was gonna carry on like that, I wouldn't of spoke to you a-tall."

MCM—Concord, N. H.

° ° °

Puzzles Us, Too

Dorris Kennedy, Kennedy Oil Co., LaGrange, Ind., wonders why people spend money they haven't got to buy things they don't need to impress people they don't like.

TO PAW, ET AL.

My tank is dry, my tires are smooth
My engine knocks like thunder.
And when my springless jaloppy moves
It shakes me up down under.

But don't mind me, let the octane be
at 70 or still littler,
Just so it's guaranteed to put
The skids to Adolf Hitler.

—Pete Roll Poet

° ° °

Cooking Hint

London — According to Stars and Stripes, a GI wrote his girl back in the States that he had attended a dinner where they had WAAF's (Women Auxiliary Air Force). His girl, anxious to please replied: "Darling, when you come home, I'll learn how to cook WAAFs to remind you of the wonderful times you had in England."

Tes, a Yankee gal.

° ° °

Times Change

Once it was considered dangerous for a girl to hold a man's hand. Now it's dangerous not to.

Western Quaker State gal.

° ° °

Rank Pride

A small group of army brides were bragging about their husbands. The first remarked that at last hers had attained his majority. "Bill has just got notice of his captaincy" thrilled the second. The third hinted that her husband was hoping for his first lieutenancy that month.

In a brief pause the fourth bride burst out bravely, "Well, Johnny still has his privacy, anyway!"

—One of the Smith gals.

° ° °

Some girls like oil men who are tough and rough. But most of them like something tender about them—especially legal tender.

Mrs. Mack from Albuquerque.

° ° °

Used to It

Girl: "Will you love me when my hair has turned to silver?

Boy: "Why shouldn't I? I've loved four shades already".

—Washington Lu.

° ° °

"Coming Mother"

"Crack this one open for me", he said, as he handed her a biscuit and a nut cracker. Thus ended another honeymoon.

—Madleen of Evansville

AFTER VICTORY...

AIRPLANE FUEL POWER IN AUTO GASOLINE!

"FLYING HORSEPOWER"

FOR AMERICA'S CARS!

"FLYING HORSEPOWER" is *super* power—found in aviation gasoline refined with the aid of Socony-Vacuum's new TCC Process and revolutionary new Bead Catalyst.

It gives our warplanes far greater speed, range and climb.

It establishes, beyond question, Socony-Vacuum's leadership in the development of catalytic-cracked super octane fuels.

This is important to every gasoline dealer. For it means that, after the war, Socony-Vacuum will have both the knowledge and the facilities to blend finer super-power *automotive* gasolines—to give Mobilgas dealers outstanding fuel leadership, Mobilgas with "*Flying Horsepower*"!

Socony-Vacuum was the first U. S. company to recognize the value of catalytic cracking—has produced *more* catalytic-cracked gasoline than any other company.

Coming: Great Competitive Advantages for Mobilgas Dealers

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TECHNOLOGY DEPT

NATIONAL PETROLEUM NEWS

Monthly Technical Section Devoted to

REFINERY MANAGEMENT *and* PETROLEUM CHEMICAL TECHNOLOGY

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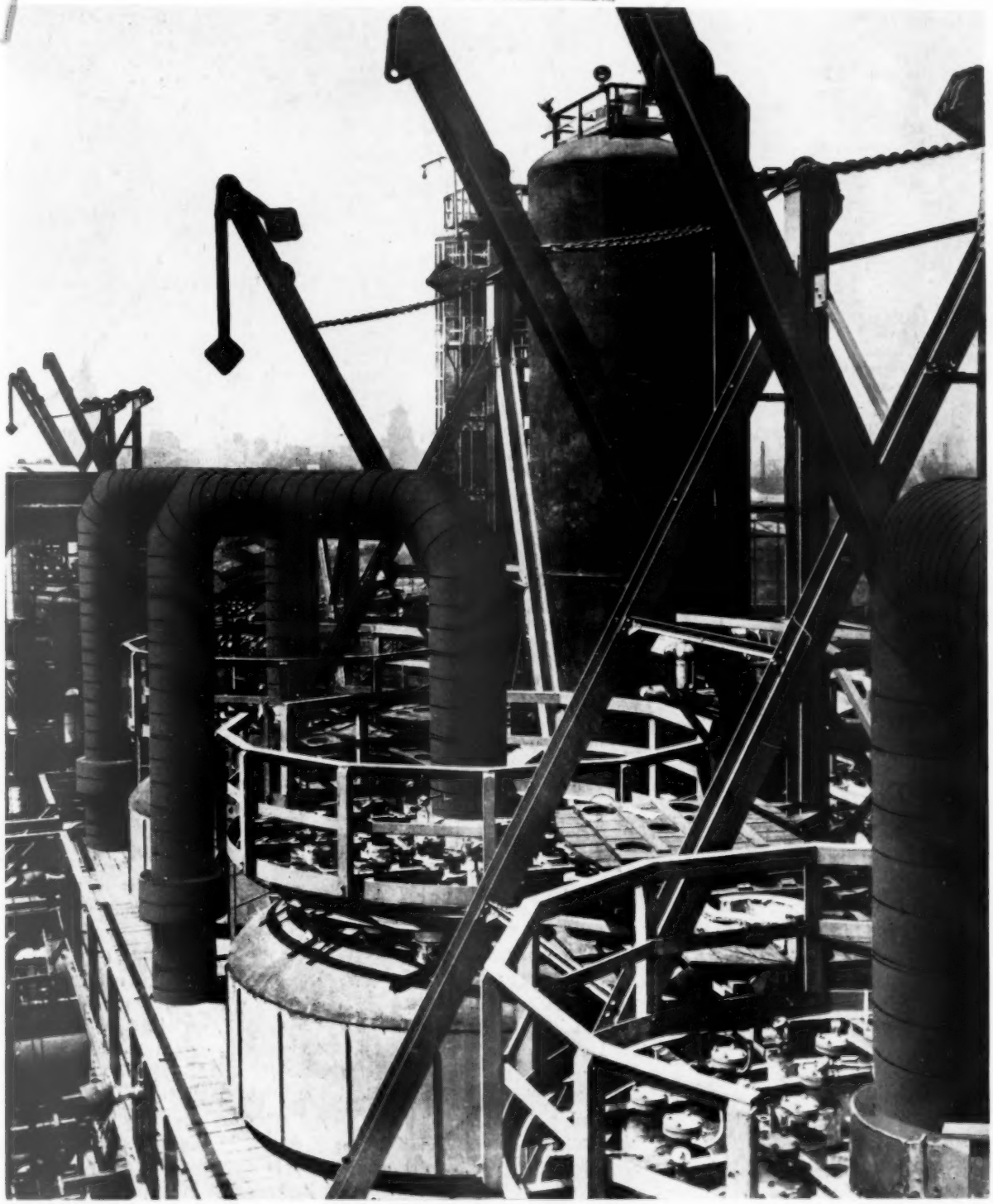
Section Two **August 2, 1944**



CONTINUOUS PRODUCTION IN A HOUDRY CAT-CRACKER of 100-octane base stock is possible in a new combination unit which went "on stream" June 17 at the No. 1 Refinery in Cleveland of Standard Oil Co. (Ohio). Uninterrupted production results from successive use of a standard six-case cracking unit for initial cracking, and an additional three-case treating unit for final processing. Note boom-type cranes shown in above photo of tops of cracking cases. These cranes are used for lifting off six-ton case tops and lowering them to the ground when repairs or maintenance are necessary, and for pulling the 15 miles of tubing inside each case.

COMPLETE DETAILS—PAGE R-491

Honored For His Part

In Oil's Wartime Program

Walter Miller . . .

Technologists of the petroleum industry each year by tradition name an honorary guest for the annual dinner of their Committee D-2 of the American Society for Testing Materials. Honor guest for 1944, at the dinner held June 28th in New York, was Walter Miller, vice president of Continental Oil Co., Ponca City, Okla., for his contributions in various of the industry's wartime programs.

He is a member of the refining committee and chairman of the technical subcommittee for Dist. 2 of PAW. He is also a member of the technical advisory committee of the Petroleum Industry War Council, and in these capacities has played an important part in the aviation gasoline program. Mr. Miller is an honorary member of Committee D-2 of the A.S.T.M. on Petroleum Products and Lubricants, which develops standard test methods and specifications for petroleum products.

Mr. Miller's only scientific degree is that of Honorary Doctor of Engineering, awarded by Tulsa University in 1943. He is self-taught in chemistry and engineering and has almost 30 years experience in refining. He started as a yield clerk at the Bayonne, N. J. refinery of Tide Water Oil Co. in 1909 and in 1916 went to the Mid-Continent, where he ran some of the early refineries located there. He has been for many years with Continental Oil Co. in charge of manufacturing.

REFINERY MANAGEMENT *and*
PETROLEUM CHEMICAL TECHNOLOGY

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A MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS *incorporating International Petroleum Technology*

Simplified Catalytic Cracking is Key To Many Refiners' Postwar Needs

By D. P. Thornton, Jr.
Assistant Editor NPN Technical Section

TWO prime considerations are involved in the small refiner's ability to install catalytic cracking facilities after the war.

The first is that such a process must be standardized for commercial operations before the small refiner can afford to pay $500,000 or more to install it. The refiner in this class cannot afford to pioneer a new process and let the fourth or fifth installation—perhaps in a competitor's plant—benefit from the difficulties experienced in the preceding installations.

The second consideration is that the process must either provide for the conversion of existing thermal equipment or else it must be of such nature that thermal equipment can be economically operated in conjunction with it. The average small refiner cannot afford to throw his present thermal equipment on the salvage pile while it is still worth, considering depletion, from $100,000 to $300,000 of its original cost.

Offsetting these factors, however, are very definite advantages of catalytic cracking in postwar refining, to operators of both small and large plants. The chief advantages are listed as follows by Wright W. Gary, president of Filtrol Corp., Los Angeles, who held the position of Director of Refining under the former Office of Petroleum Coordinator:*

1—Larger volumes of gasoline per barrel of crude oil charged to the plant.

2—Higher antiknock value for catalytically cracked gasoline.

3—Low cost new byproducts for petroleum hydrocarbon chemicals, synthetic rubber and plastics.

Mr. Gary believes these advantages are great enough that development work will be stimulated and the catalytic cracking process simplified to meet the postwar needs of the small refiners. He states further:

A Postwar Handicap

"Catalytic cracking radically revises refinery product balances and economies. It is therefore probable that refiners who do not have the benefit of such facilities in postwar operations will be seriously handicapped competitively. The types of catalytic cracking installations now bearing the burden of the war effort are necessarily large units and were expensive to install. Application of these processes to the small capacities of the average American refiner is difficult. Considerable engineering progress has been realized along this line during the past three years, partly resulting from commercial simplification by operating experience. Nevertheless, much is still to be desired.

"In analyzing the application of catalytic cracking to the small refiner, two phases of the problem exist. The first consideration is minimum capital cost, and the second is moderate operating expense. Since catalytic cracking usually substitutes, in part, existing thermal cracking equipment, one method of minimizing capital cost is to utilize the existing equipment to the greatest possible extent. In addition, the catalytic cracking process should be carefully scrutinized to identify those features of the process which promote costly equipment or steps which are required of necessity by large units, but may be modified and simplified for small operations. Examples of a few of these are as follows:

"(1) Short time cycles are necessary for large units but they probably can be increased considerably for small scale operations to the point where automatic valves, piping and complexity of equipment can be simplified.

"(2) Revivification costs money in equipment. Efficiency of heat exchange is of lesser importance in a small unit. Heat dissipation from revivification over a longer period of time should promote marked economies.

"(3) Catalyst movement costs money in equipment. Fine powdered catalyst has the disadvantage of entrainment and separation. A stationary bed increases problems of revivification, catalyst make-up application, and uniform catalyst activity. Large sized catalyst requires elevators, conveyors and distribution problems to prevent channeling of either vapors or catalyst. To eliminate many of these disadvantages, it would appear, therefore, that an intermediate sized catalyst which is coarse and rugged enough to minimize entrainment or attrition, applied as a 'boiling bed' of granules is particularly promising for small plant application.

"(4) The catalyst should be cheap. A simple catalytic cracking unit cannot afford to protect the catalyst to obtain maximum life characteristics. Therefore, catalyst consumption per unit of thruput probably will be greater and expensive catalyst usage would be prohibitive. On the other hand, sufficiently high activity is desired to get required conversion without excessive temperature or reaction volumes."

At present, most of the small refiners with thermal cracking equipment expect to convert their codimer or other polymerizing facilities to the production of high-octane blending agents from refinery gases and, possibly, from light ends extracted from natural gasoline. Blends of these materials with straight-run and thermally cracked gasolines, plus lead, will constitute the motor fuels they expect to market at the close of the war, it is stated. Their octane ratings probably will be at prewar levels. Conversion of codimer equipment and reversion of other refinery operations to a peacetime status will, of course, be contingent on crude supply as well as on the needs for aviation gasoline and burning oil in the period after the cessation of the war in Europe but while we are still at war with Japan.

Thus it is indicated the small refiners will stand pat on their thermal equipment and run it for at least some time after the war ends. Many of them are licensees of processes developed by others. They expect the owners of the processes they now have to do the necessary development work to make available some commercially-proven means of converting present thermal equipment to catalytic cracking.

At Work on Problem

Along this line, it is known that several process owners are at work on practical methods of adding a catalyst chamber and recovery equipment to a thermal unit in such a manner that new construction costs will not be prohibitive and the resultant product will be competitive with that made by larger catalytic units.

A refinery process contractor's representative told the writer he knew of no catalytic unit with a capacity smaller than 5000 b/d that has been proven commercially feasible. He added that the cost of a 10,000 b/d unit is only slightly greater than the 5000 b/d unit and the cost differential between a 10,-

* Personal correspondence with the writer.

000 b/d and a 15,000 b/d unit is still smaller. Many small plants with total crude charging capacity of 2000 to 5000 b/d will not be able to use even a 2000 b/d cracking installation, however.

Some of the small refiners believe it will be at least a few years after the war before there is general need of motor gasolines of higher than prewar octane ratings. They believe that, at the rate at which automobile manufacturers will turn out new cars, it will take a long time to replace the present worn out models, handle normal attrition and build back to the 29,000,000 level of 1941 passenger car registration from the 1943 preliminary figures of 25,000,000 units. And of these 25,000,000 passenger cars, none are less than two years old, while the actual average age is far greater. Thus these small refiners do not anticipate an "octane race" for several years. Also, if published beliefs of some authorities are correct, there will be no great required advance in octane number—beyond 85—for many years.

Others in the small refiner class expect to hold back on installing catalytic cracking facilities because they believe radical changes in catalysts are yet to come. Such changes may later render present catalytic equipment obsolete. They point to the improved products with attendant operating economies from substituting synthetic or improved natural clay catalysts in several well-known processes. Some believe still more radical changes are coming, such as catalysts which will permit use of most anything as a cracking stock instead of the carefully-prepared stocks now used in making 100-octane gasoline.

Another future "if" which some of the small refiners may be juggling, with reference to the possible octane rating of postwar fuels, is the use of solid-fuel injection systems for spark-ignition engines. While very little has been published on this type of "carburetion," now used in airplane engines, if it is adapted commercially to automotive vehicles there is the likelihood that vapor pressure and perhaps distillation requirements of today may later become obsolete. Some sort of semi-Diesel operation, if perfected, would have a depressing effect on octane requirements also. Should vapor pressure requirements become less significant, octane ratings likewise, characteristics of fuels made in existing thermal equipment may be adequate for public surface-vehicle demand.

Processes Described

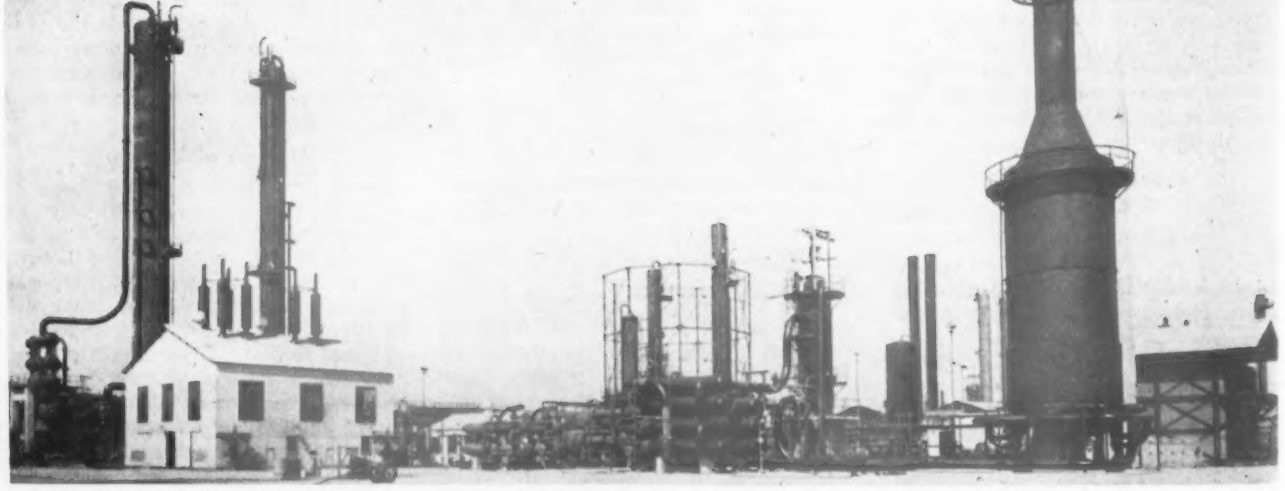
One catalytic process which is being studied by the small refiner is the so-called "Suspensoid Process", about which little has been said in the past year. It entails the admixture of a finely-divided catalyst with the charge stock, passing the mixture through a conventional thermal cracking furnace, and subsequently removing the catalyst by filtration. The spent catalyst then is revivified in some type of kiln before returning to storage for re-use. The refiner would be called on to install a mixer, a filtering arrangement, a kiln, and means for transporting catalyst from filter to kiln, from kiln to storage, and from storage to point of admixture with charge stock.

Another process, now patented, uses catalytic cracking in conjunction with thermal cracking. Each, so to speak, would prepare feed stock for the other in that some catalytically cracked material would be mixed with the reduced crude charge to the thermal unit, and thermally cracked product would be mixed with more reduced crude as charge for the catalytic unit. Good operating economies and high quality products are claimed for the process. It is not known whether a full-scale plant has been operated in this manner.

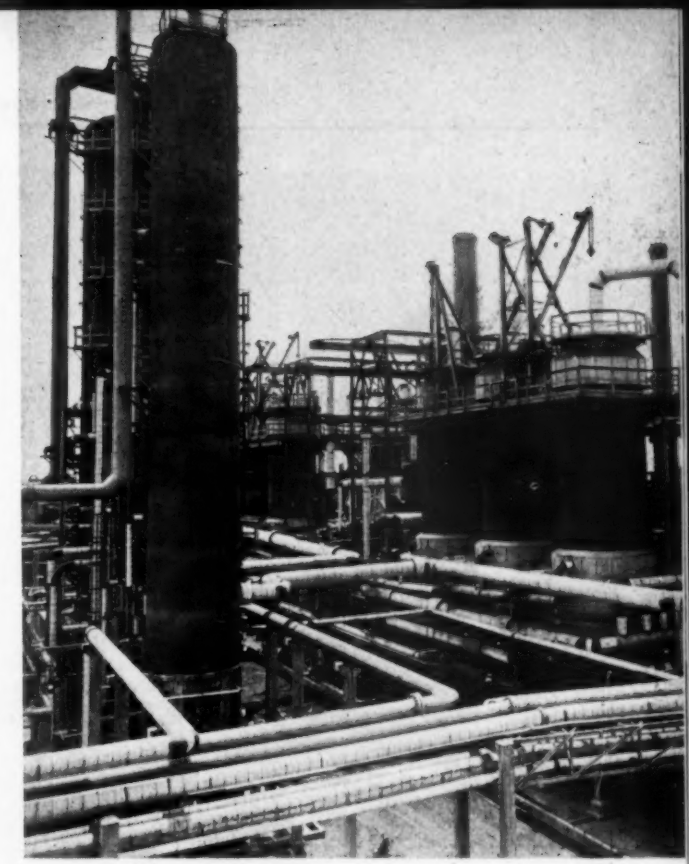
Still another catalytic process which has been through semi-commercial scale tests, Phillips Petroleum Co.'s "Cycloversion" process is designed to utilize existing thermal equipment as well as all-new construction. Gas-oil or naphtha charge is vaporized simultaneously with steam in separate convection coils of a conventional heater, mixed, and the mixture raised to desired operating temperature at low pressure in the radiation coils of the heater. Hot vapors then are passed through one or more fixed-bed catalytic reactors, sensible heat being recovered subsequently in waste-heat exchangers, going thence to product separation. Catalyst regeneration is by controlled air combustion. The process is reported very flexible, capable of operating on a wide variety of charge stocks.

Seemingly, adaptation of an existing thermal plant to "Cycloversion" would require only the installation of catalyst chambers and catalyst regeneration system, the latter including an air-and-steam superheater and the necessary air compressors. Possibly the soaking drums or other reaction vessels of some thermal processes could be revamped for service as catalyst chambers, since alloy construction is reported as unnecessary, and probably some rebuilding of the existing heater would assure heating charge vapors to reaction temperature in as short a time as possible, minimizing thermal cracking in the heater coils.

Thus it appears that majority opinion among the small refiners is that the strictly topping type plant will soon disappear, while opinion is divided on whether or not the large-scale advent of catalytic cracking will entirely displace thermal cracking, to meet postwar competition. It is evident, however, that the majority of small refiners are keenly watching for a catalytic cracking process adaptable to their individual needs.



New catalytic hydrogenation plant at Shell Oil Co.'s Wilmington-Dominguez, Calif., refinery produces a high quality aviation gasoline component made directly from raw materials which otherwise would be of little value in the war effort



The first of the two fractionating columns on the right serves the 3-case treating section (shown at the right of the photo) of Standard's new combination Houdry Catalytic Cracking unit. The second column makes the initial separation of products from the 6-case cracking section, which is partially shown in the background. The first tower is 10½ ft in diameter by 77 ft tall, while its mate is 18 ft by 78 ft

New Houdry Cat Cracker Produces Continuous Stream Of 100-Octane Base Stock

By William F. Bland
NPN Staff Writer

THE first combination-type Houdry Catalytic Cracking unit for continuous production of aviation gasoline base stock is now in operation at the No. 1 refinery in Cleveland of Standard Oil Co. (Ohio). It went "on stream" June 17.

Unlike other Houdry units, which generally consist of only six cracking cases, Standard's new plant includes not only the usual six-case unit for the initial catalytic cracking operation, but also an additional three-case treating unit for further processing of the distillate from the first pass to bring it up to 100-octane base stock quality.

Practice in other plants using the six-case Houdry unit is to work on the "block" plan—collecting and storing the first run distillate over a period of time, later running it back through the same cases for the additional cracking which is necessary. The results, intermittent production and the need for additional storage, are eliminated in Standard's installation by adding the additional three cases.

Total cost of the plant, including auxiliary pipelines, tankage and utilities, is estimated by one company official to be approximately $9,500,000.

Process Flow

Feed stock for the cracking units is obtained from Illinois crude, which is run through the usual primary distillation and split into light hydrocarbon gases, gasoline, kerosine, gas oil, and asphalt.

Fresh wide-cut gas oil from this fractionation (29.0° API, 10%—525°F, 90%—890°F, 0.4% sulfur) is charged through a preheat train and furnace at the rate of 16,400 b/d. Preheating brings the temperature of the charge up to 470°F, which is then raised to 810°F in the charging furnace. Although the furnace is designed to heat the feed stock up to 850°F, in actual practice 810°F has been found satisfactory.

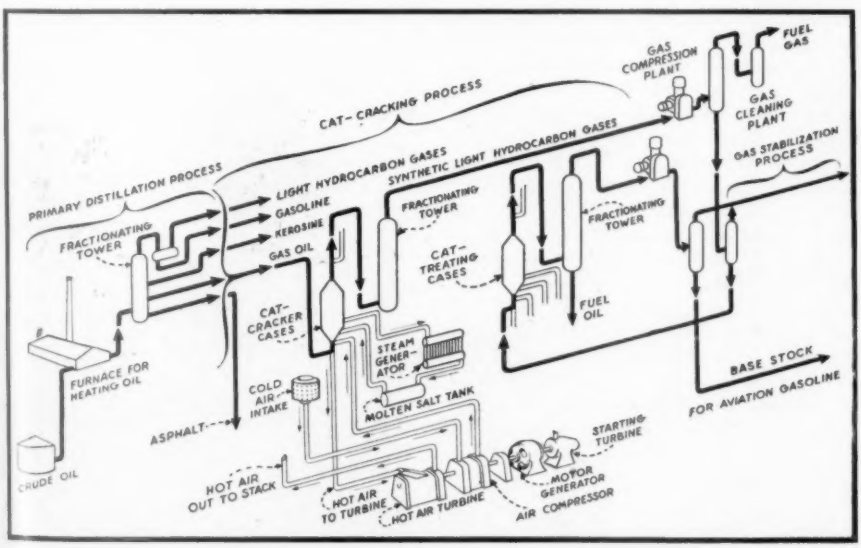
After heating, the gas oil charge passes into the tar separator, where non-vaporizable fuel oil is eliminated.

The dry vapors leaving the separator are combined with 10% (by weight) of superheated steam—810 to 825°F, and then pass into one of the three pairs of cases in the 6-case cracking unit, where the initial cracking operation takes place.

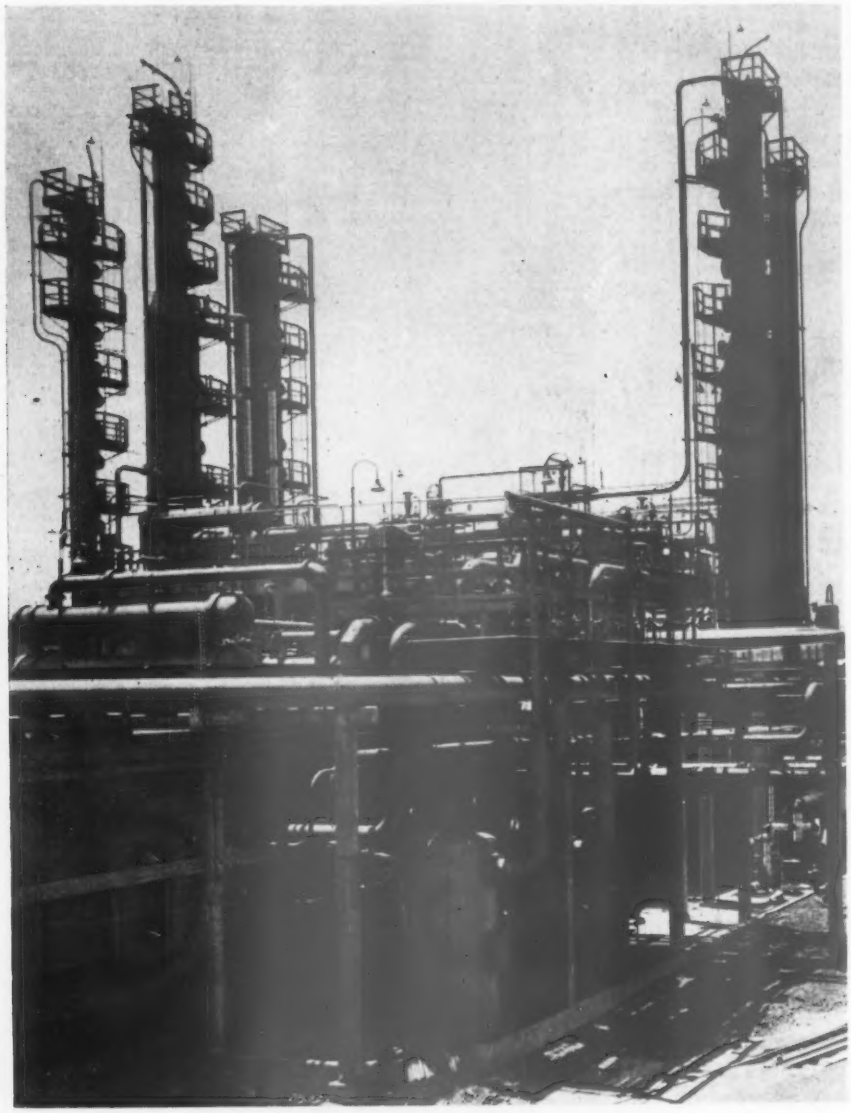
Temperature in the cases is maintained near the 810°F level during the cracking process by circulating molten salt through tubes inside the cases. Operating pressure at this point is about 8 psi.

Products from this first cracking operation are carried into the synthetic crude tower, where they are separated into cycle gas oil and overhead vapors.

The cycle gas oil is broken up into two cuts—light (33° API, IBP—463°F, 90%—590°F) and heavy (20°API, IBP—600°F). Part of the light cut is sent to the absorbers where it is used as an absorption medium, while the balance of it is stored and later used as feed for Standard's thermal crackers. The heavy cut is used immediately as feed for the thermal units. In the event that feed stock for the Houdry units becomes short, part of this gas oil can be re-



Process flow diagram, showing how the 6-case cracking units and 3-case treating units operate in succession, permitting uninterrupted production of 100-octane base stock



Gas plant for Standard's new Cat-Cracker. At extreme left is Absorber (74 ft high). Next to it are Depropanizer (90 ft) and Debutanizer (78 ft). At the right are the Stabilizer Tower (81 ft), in which final distillate is stabilized for aviation base stock, and Butane Tower (78), in which overhead butanes and pentanes are separated for alkylation feed and aviation blending. Foreground shows compressor room and gas plant pump room.

cycled, mixed with fresh gas oil, and run through the cracking cases again.

Overhead vapors taken off the top of the synthetic crude tower are condensed into raw distillate and gas. The raw distillate goes to a gas-water separator, where any water is removed. The gas is compressed to a pressure of 135 psi and recombined with the distillate to recover more first-pass gasoline.

The residual fuel gas, together with similar gas from the three-case treating unit, is passed into an absorber where final recovery of valuable materials is effected.

The total distillate is processed through a depropanizer, which removes additional fuel gas, and a debutanizer, which separates butane for alkylation plant feed. The resulting distillate (56°API, 10%—125°F, 90%—400°F, 0.1% sulfur) has a CFRR octane number of 88, and serves as feed stock for the second catalytic step, which takes place in the 3-case treating unit.

Treating Cases

After being preheated to 325°F, the debutanized distillate from the first catalytic cracking step is run through the charging furnace, where its temperature is increased to 810°F. The resulting vapors, under a pressure of 35 psi, are passed into one of the three treating cases, where the molecules are further broken up and rearranged.

Outlet products from these treating cases are separated in the treated synthetic crude tower into cycle gas oil, heavy naphtha byproducts, and overhead —which is condensed into treated distillate and gas.

The treated distillate and gas are compressed to a pressure of 135 psi and recombined. Residual gas is sent to the absorber tower used with the 6-case unit for further recovery.

The recovered distillate is stabilized for aviation base stock in the stabilizer tower, and the overhead butanes and pentanes are separated for alkylation feed and aviation blending in the butane tower.

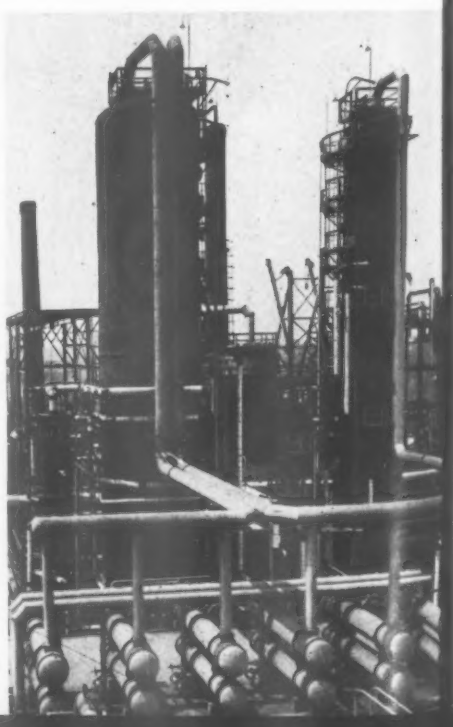
Catalyst Cases

The nine catalyst cases are identical, arranged with three pairs of two parallel cases in the cracking circuit and with three single cases in the treating circuit. Each case is approximately 12 ft. in diameter by 42 ft. high, and contains 34,100 liters (46,000 lbs.) of catalyst.

Oil vapors are passed through one pair of cracking cases (and one single case in the treating circuit) at a time. After a 10 minute on-stream period, the flow of oil vapors is switched to the second set of cases, and subsequently to the third, while the catalyst in the cases just used is regenerated.

The complete cycle through all three sets of cases thus requires 30 minutes, and by the time that cycle has been completed the catalyst in the first set of cases has been regenerated and is again ready for use.

The first five minutes of the 20 minute off-stream period allowed for each set of cases is an evacuation period, during which oil vapors are removed from the cases with a vacuum purge accompanied by steaming. Actual regeneration requires 10 minutes, and is accomplished by forcing compressed air (45 psi.) through the



Fractionating Columns for 6-case unit (left) and 3-case unit (right). Overhead vapors pass to battery of condensers in foreground before going to gas plant. Note extensive use of welded joints in piping

catalyst, from which it burns off the carbon deposited on the pellets during the cracking process.

During the last five minutes of the 20-minute period, the regenerated cases are freed of air and gases by vacuum, and then repressured by vapors from the synthetic crude tower.

Molten Salt Removes Heat

The compressed air used in burning off the carbon deposit on the catalyst is preheated to 785°F, but once the carbon starts to burn considerable heat is released. This heat released during the regenerating period is removed by circulating molten salt through tubes inside the cases.

These salt tubes are the same ones used to supply extra heat to the oil vapors during the cracking process. During the regeneration process, however, the heat removed by the salt tubes is more than enough to maintain proper temperatures in the other cases, and the excess heat is utilized by passing the salt through two special salt boilers which generate high pressure steam. The combined output of these two boilers is approximately 71,000 lbs. of steam per hour, at 450 psi. This steam is used within the unit for process purposes and for driving mechanical equipment.

Salt used in this system is a mixture of 40% sodium nitrite, 7% sodium nitrate and 53% potassium nitrate. The original charge of this mixture was 1,450,000 lbs.: unless a break occurs in the lines at some point no additional salt need be added, since the salt circulates within a closed system. Two large drums approximately 14 ft. in diameter by 60 ft. long serve as storage and surge tanks for the salt system.

Table I

(Specifications of Towers at Standard's New Plant)

Tower	W'th (ft.)	H'ght (in.)	Trays	Max. Press. (psi)
Synthetic				
Crude Tower	18	78	22	5-8
Absorber Tower	3	74	32	135
Depropanizer	3½x6½	90	34	300
Debutanizer	6½	78	34	85
Treated Synthetic				
Crude Tower	10½	77	22	35
Stabilizer Tower	4x6	81	34	150
Butane Tower	3½	78	34	235

Gas Turbines Compress Air

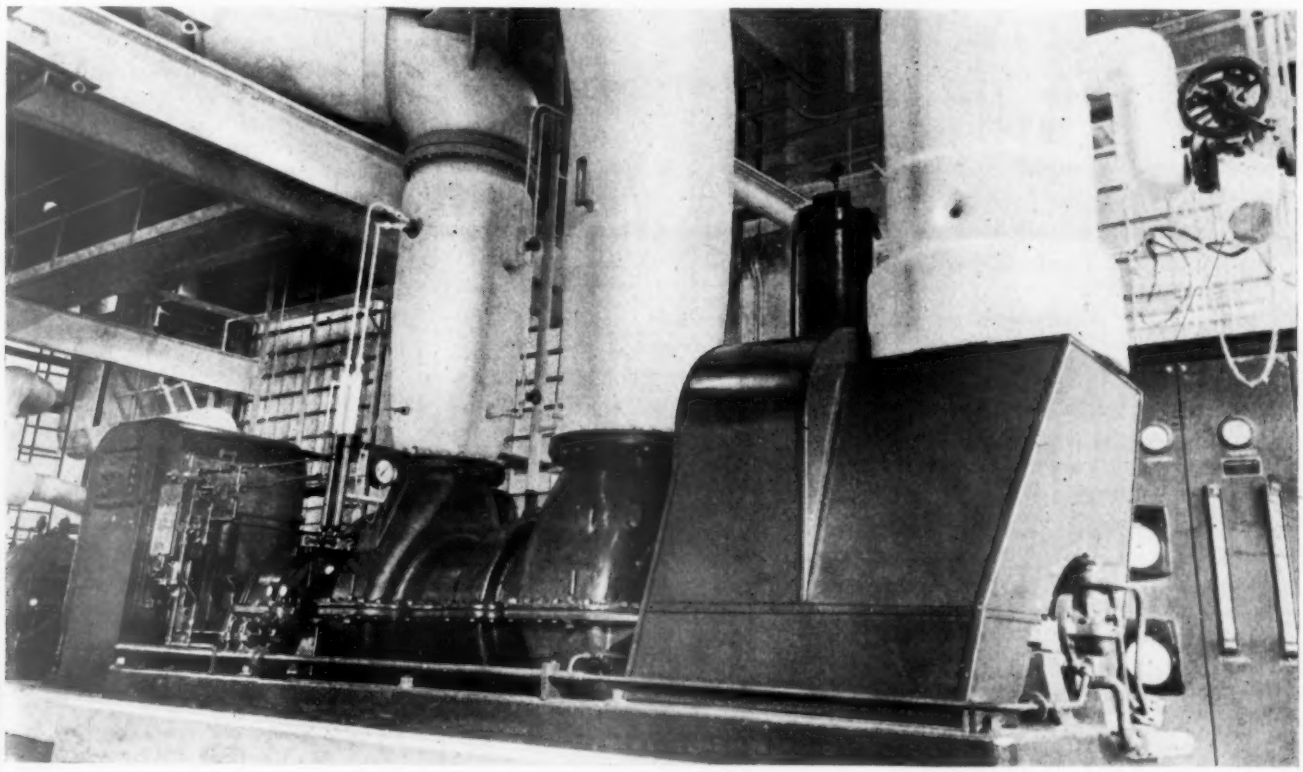
Interesting feature of the Houdry type unit is its use of the gas turbine to furnish compressed air for regenerating the catalyst, the gas turbines themselves being run by the hot exhaust gases which result from the regenerating process.

Two gas turbines, or turbo-compressors, are used in Standard's set-up, one for each of the two series of cases. These compressor units are composed of a gas turbine, compressor, gear reducer, induction generator and steam turbine, all integrally connected.

Fresh air is taken in from the outside atmosphere, passed through filters, and compressed to about 45 psi. This compressed air is then passed through the catalyst cases, where the carbonaceous deposit on the pellets of catalyst is burned off. The hot flue gases formed during regenerating cycle in the cases are passed through the gas turbine, where they are utilized to furnish power for driving the compressors and compressing additional air. Thus, once the system is started up it keeps itself going by using the energy available on the catalyst in the form of carbon.

An excess of power is sometimes developed in the gas turbines, over and above that required to drive the compressor. In order to control the speed of the unit, an induction motor operating through a gear reducer acts as a speed governor. This governing action is accomplished by the motor performing as a generator when the speed is above normal, thus imposing a breaking load on the unit. When the speed is below normal, it functions as a motor and supplies power to the unit in order to maintain proper speed.

With the turbines operating at top speed and being supplied with the normal amount of hot exhaust flue gases from the catalytic cases, these two generators



Two turbo compressors supply compressed air for burning off carbon deposit on catalyst during regeneration periods. Hot flue gases that result are then used to run gas turbines which power compressors. Center duct is inlet for fresh air from atmosphere, which is compressed to 45 psi and sent to catalyst cases through duct at left. Hot flue gases are returned to gas turbine at the right and later exhausted to atmosphere

will produce between them about 200 kilowatts, at 2300 volts.

The steam turbine on the end of the shaft is used for starting-up purposes when the unit is cold.

The gas turbine on the larger unit (which supplies compressed air to the first series of six catalyst cases), develops 6200 HP. at 5180 rpm. The compressor on this unit delivers 40,000 cfm. of air at 45 psi. The induction motor has a rating of 1250 HP.

For the smaller unit, the gas turbine develops 4000 HP. at a speed of 6000 rpm. The compressor delivers 23,000 cfm. of air at 45 psi. The induction motor has a rating of 800 HP.

Control Room

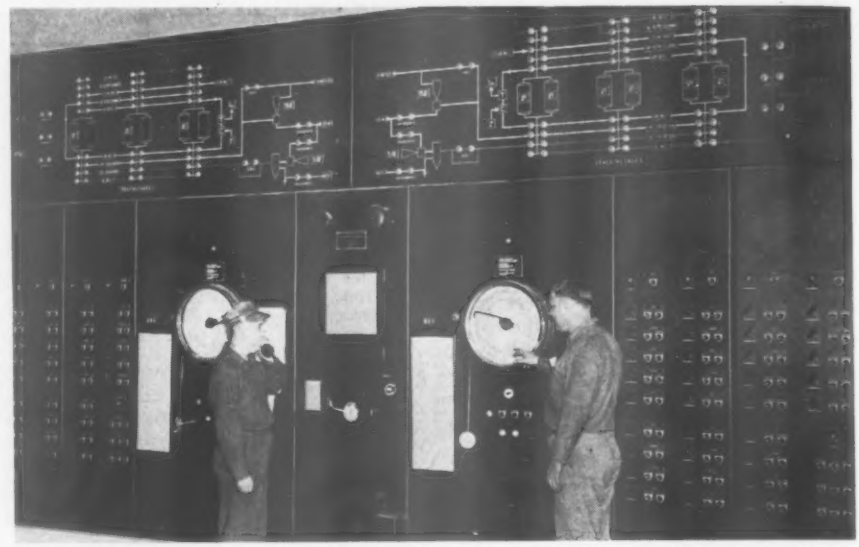
All operations are automatic—switching oil vapors from one case to another, purging and repressuring, regenerating, maintaining constant temperatures, etc., with the majority of the control and recording instruments being located in the main control room.

Key instrument in the control room, and heart of the entire Houdry cycle, is the cycle timer, which automatically times the valving of the units. Standard's installation has two such timers—one for the cracking cases and a second for the treating cases.

There are a total of 900 electrical contact points in each timer. Every 30 minutes the timer makes one complete revolution through all of these 900 contacts, automatically opening and closing in proper sequence the various valves that carry out the 30-minute cycle in each case (cracking—10 min., evacuation—5 min., regenerating—10 min., repressuring—5 min.).

In many instances it was necessary to use construction materials other than those which would normally be used, because of wartime restrictions.

Due to the shortage in steel, reinforced concrete pipe supports have been used. The tar cooler box, which under normal conditions would be made of steel plate, has been constructed of reinforced concrete. In both of these items, the substitute material will be kept in use as long as it remains serviceable.



Two cycle timers control operation of all nine cases, automatically opening and closing valves in proper sequence. Flow diagram above timers shows position of key valves at all times by means of lights. Auxiliary switches are provided for emergency operation

Fire resistant treated wood has been used for walkways, platforms and railings around the structures, instead of steel plate or grating and angle iron. All of these wood installations are to be replaced as soon as possible.

Another instance of improvising exists in the cranes which are located above the catalyst cases to facilitate removal of the 6-ton case covers whenever it is necessary to replace tubes. Normally Standard would have installed a traveling crane if the necessary materials had been available. Instead they are using a simple boom arrangement, as shown on the front cover of this issue.

Because of the location of Standard's No. 1 refinery in the heart of Cleveland's industrial "flats" area, an exceptionally large flare stack has been provided to take care of emergency cases when it may be necessary to dispose of large quantities of gas in a hurry. This self-supporting stack has a total height of approximately 220 ft., and the pipe is among the largest in the plant—24 in. in diameter.

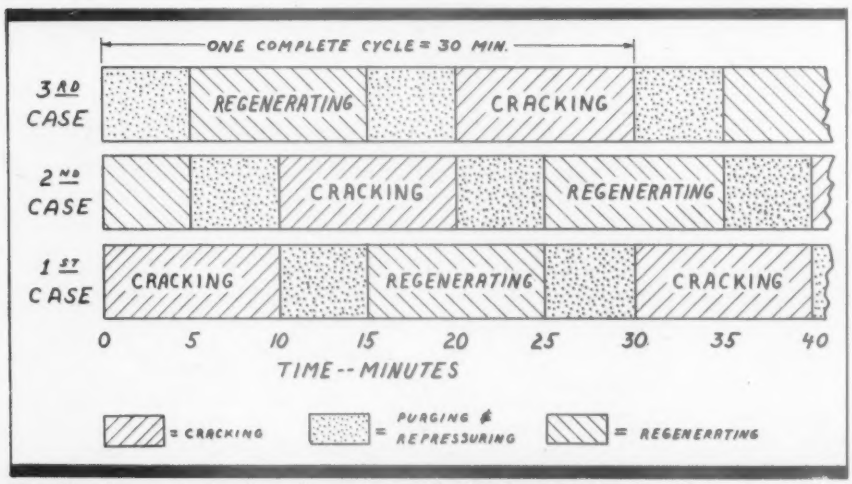
Postwar Conversion

Looking into the postwar future when demands for 100-octane aviation gasoline will not be nearly as large as they now are, Standard has made provisions on the treating side of the unit for installing three additional cases.

When and if this addition is made, they will have two complete cracking units which can both turn out a high quality premium motor gasoline.

No information regarding the output of Standard's new Houdry unit has been released, except that production from this plant makes it possible for approximately 1500 fighter planes to fly a sortie or escort bomber flights over the channel each day.

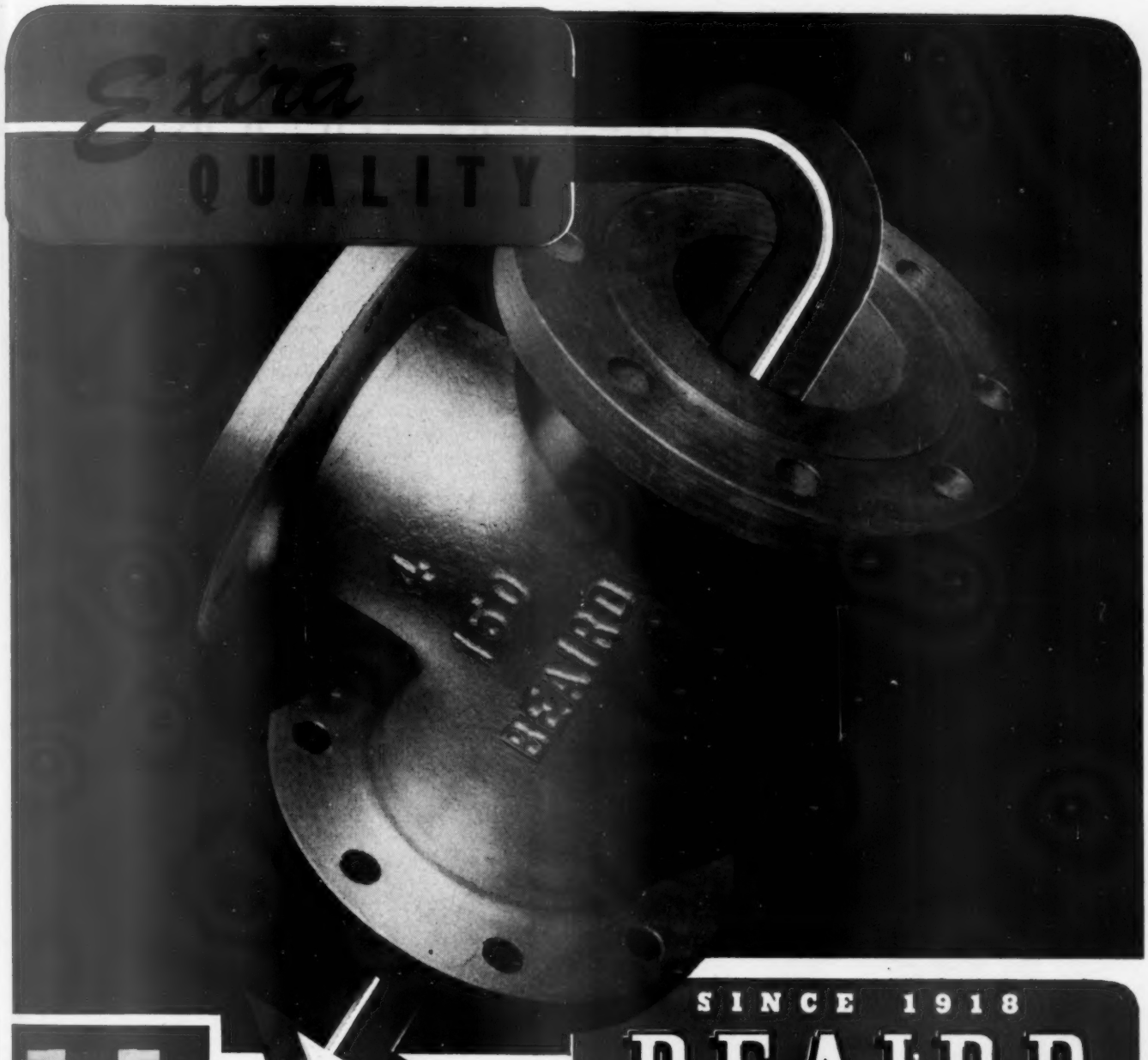
In the design and construction work, Standard was assisted by Catalytic Development Corp. and the E. B. Badger & Sons Co.



The Houdry cycle involves four steps—10 minute cracking, 5 minute evacuation and purging, 10 minute regenerating, and 5 minute repressuring. Sequence on cases is staggered so that one unit is always cracking

Economic Design of Pressure Vessels

"External Pressure Vessels," the fourth in a series of articles by E. F. Brummerstedt dealing with methods for determining the most economical design of pressure vessels used in refineries, will appear in the Sept. 6 issue of the Technical Section.



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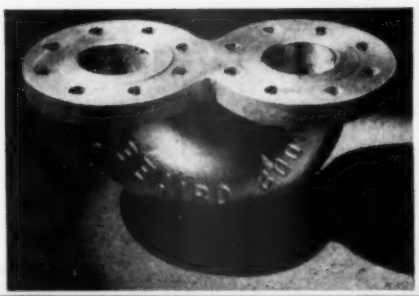

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PREVENTIVE MAINTENANCE PROGRAM KEEPS VITAL PUMPS ON THE JOB

Classes for Plant Operators Demonstrate Practical Ways of Guarding Essential Refinery Equipment Against Breakdowns

PREVENTIVE Maintenance is being taught and practiced at the Bayway refinery of Standard Oil Co. of New Jersey to avoid breakdown of pumps, valves and other vital processing equipment which is difficult to replace under wartime conditions.

Supervisors of the Process and Mechanical Departments have organized a course of instruction designed to emphasize to operating personnel the serious situation existing today with respect to materials and parts, and then to show them how they can help increase wartime production by taking care of critical equipment.

The Bayway program recognizes the key part that process operators and men actually handling the equipment can play in detecting faulty units and taking corrective steps to prevent damage. The Preventive Maintenance course consists of three one-hour sessions, with the material to be presented at each session well planned and outlined in advance. The sessions are held in a special "laboratory" provided with actual equipment for demonstrations. To date some 573 men have taken the course (including a field machinists group). Classes vary in size from 12 to 22 men. Compensation for the time spent attending the course is at regular overtime rates.

Because pumps play such an important part in refinery operations, the main portion of Standard's course as developed so far has been devoted to the proper care and operation of this type of equipment. Two main classes of pumps are covered, steam and motor-driven units. Some time is also given to the care of various types of gate and plug valves.

To check the effectiveness of the instruction program, Standard recently made a comparison of specific breakdowns over two winter-month periods before and after the introduction of the course. The study covered four major types of breakdowns in pumping equipment, and showed that these troubles were reduced by 57% as a result of the preventive maintenance course. See Table 1.

TABLE 1

Comparison of Pump Maintenance Before and After Preventive Maintenance Courses

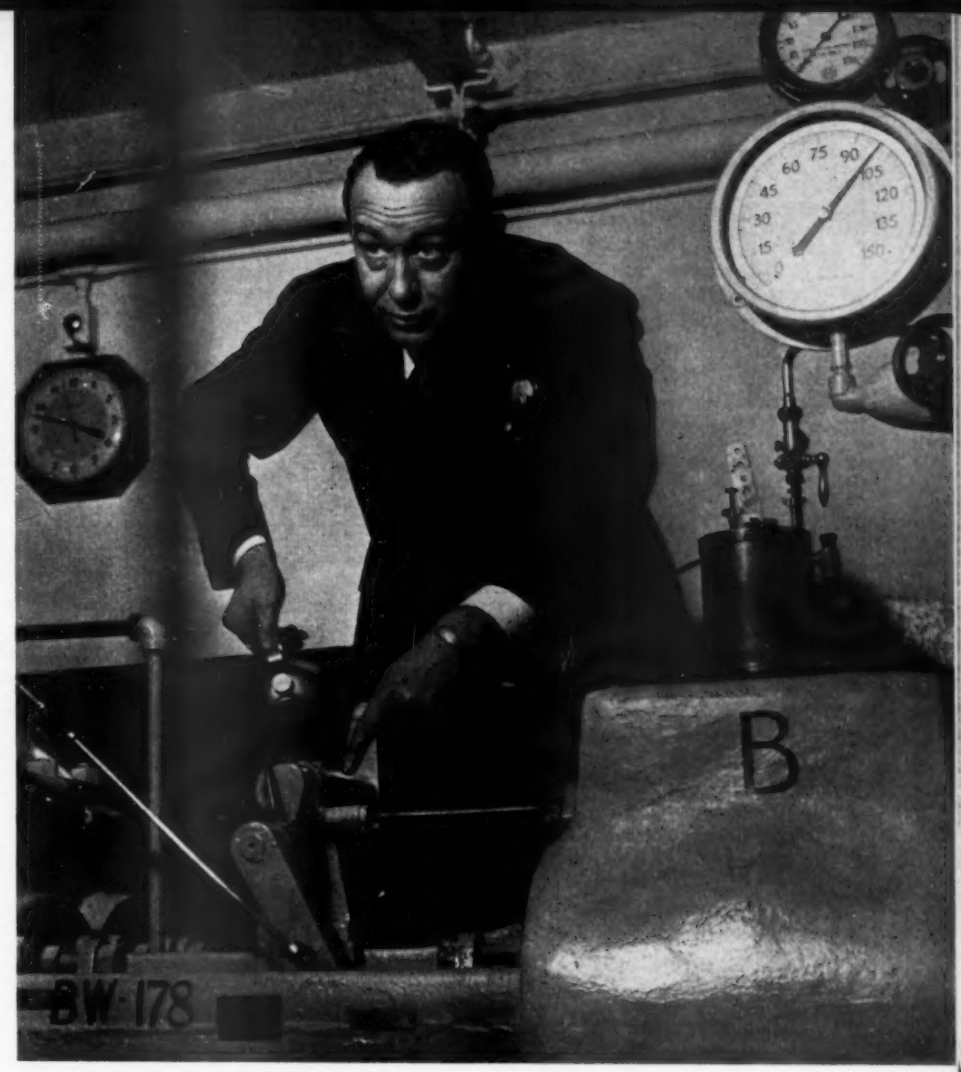
	Before Program Nov. 1942 to Apr. 1943	After Program Nov. 1943 to Apr. 1944
Cracked steam cylinders due to freeze-up	25	8
Cracked liquid ends due to freeze-up	12	6
Burned-out motors due to improper starting	20	6
Bearing failures due to improper care of lubricant, spraying cooling water into bearings, etc.	130	60

To further determine how the program has contributed to decrease maintenance difficulties, a report covering motor and pump failures is submitted weekly to the process superintendent by the pump maintenance dept. Each report of damage involving personnel is routed to the department head, who determines whether the individual concerned has attended the preventive maintenance course. Although definite figures are not yet available, one department head at the refinery claimed that not more than 6 instances were found in which persons who had taken the course were responsible.

Objectives

As pointed out, the entire Bayway refinery course is built up around the operator as being in the "kingpin" position for practicing preventive maintenance. He can be the first to detect signs of trouble indicated by unusual noises and different operating sounds of his equipment. He is therefore in a position to take corrective steps to prevent what might otherwise become seri-

Instructors in Standard's Bayway refinery Preventive Maintenance Courses are good showmen. They talk directly "to" the men, use gestures and pantomime lavishly. At the left, Instructor George A. Lloyd (head of the Light Oil Treating Dept.) demonstrates how NOT to pull up on cracking gland of motor-driven centrifugal pump. Note exhibit of new and scored sleeves in foreground



Each step in properly starting a pump is carefully explained, visually demonstrated. Instructor Louis H. Zepfler (Steam and Power Engineer) goes over the correct oiling procedure

ous damage. One purpose of the course is to point out these common warning signals to operators.

It is also important that the men develop correct operating practices for the equipment under their control. This will help to prevent excessive wear and excessive consumption of fuel. Here again, with the aid of actual demonstrations, in the school, the operator is shown the result of improper uses, such as throttling steam pumps with the discharge valve, overspeeding steam pumps, or starting motor-driven pumps with an open discharge valve.

The theory is followed that incorrect practices arise largely from a lack of understanding or appreciation of the principles of proper operation, rather than from negligence. It was felt that the full co-operation of process operators could be had by showing them not only what to do and how to do it in the handling of equipment, but also explaining why such procedures are correct and what happens when they aren't followed.

At all times the course emphasizes the difficulty of obtaining replacement parts and the important role which the men can play in conserving vital war production equipment.

Ultimate objectives of the course, as outlined in a manual prepared by Standard, are:

1) Maintenance of maximum war production.
2) Conservation of fuel.
3) Conservation of critical materials.
4) Conservation of manpower.

Introduction of the Course

One essential phase of the program, it is felt, is to get the men into the correct receptive attitude, to eliminate the possibility of any feeling on their part that management is trying to cram something down their throat. At each opening session a brief talk is made by the process superintendent. His remarks include a statement of the appreciation of management for the work toward the war effort performed by the employes; management's interest in the course in preventive maintenance; the critical materials situations; the knowledge that the problems can be solved, as have others, by joint co-operation. After requesting promptness in attending the sessions and announcing the compensation policy, the process superintendent introduces the instructor and turns the rest of the job over to him.

The instructor begins by explaining how the men at Bayway are helping the war effort by the production of vital materials and how anything which slows down production accordingly slows down the military operations and delays its ultimate conclusion. The needs for preventing breakdowns, keeping equipment in operation and conserving materials are all emphasized.

Instructors and Text

Six instructors, three each from the Process and Mechanical Depts., conduct the course. They took the War Manpower Commission 20-hour Job Instructor Institute course in "Job Instructor Training" (J.I.T.), conducted at the Bayway refinery in the fall of 1942, and later conducted a J.I.T. program for the refinery foremen during 1943. Each instructor is assigned definite groups to work with, and he continues with them through the three sessions of the course.

Most important job of the instructor, company officials say, is to sell the idea of preventive maintenance to the operators, and to maintain an informal atmosphere during the classes. He must be careful to avoid personal criticism, and to gain and hold the interest and confidence of his listeners.

A great deal of time and thought was put into the preparation of the instruction material. The principle followed was to keep the "lectures" to a minimum and use as many visual demonstrations as possible. After the general outline of the text was laid out, it was reviewed by the process superintendent for criticism of scope, approach and details. It was then discussed by the entire instructor group and acceptable suggestions incorporated. To obtain the proper timing for each session, tryouts were given by several of the instructors.

Since the sessions are designed to run for exactly one hour, timing was considered important. Instructors must familiarize themselves with the text, as there is time for little extemporaneous lecturing. To aid in keeping the time schedule the instructor always plans on arriving from 20 to 30 minutes early to go over the demonstration equipment and see that it is in proper operating order.

Before giving the session to the operating personnel, a preview was held before a selected group of department heads and assistants. Additional points of emphasis, new information, and angles developed at this session were noted by the entire instructor group, which was in attendance, and included in their notes.

Organization of Classes

Operators and helpers in the process department down to the level of topman, as well as a group of field machinists, have been given the course to date. Classes are held outside of working hours, either before starting a shift or after the close of a shift, and attendance is required. Men entering the plant for the 3 to 11 shift attend a class from 1:45 to 2:45 p.m., while the

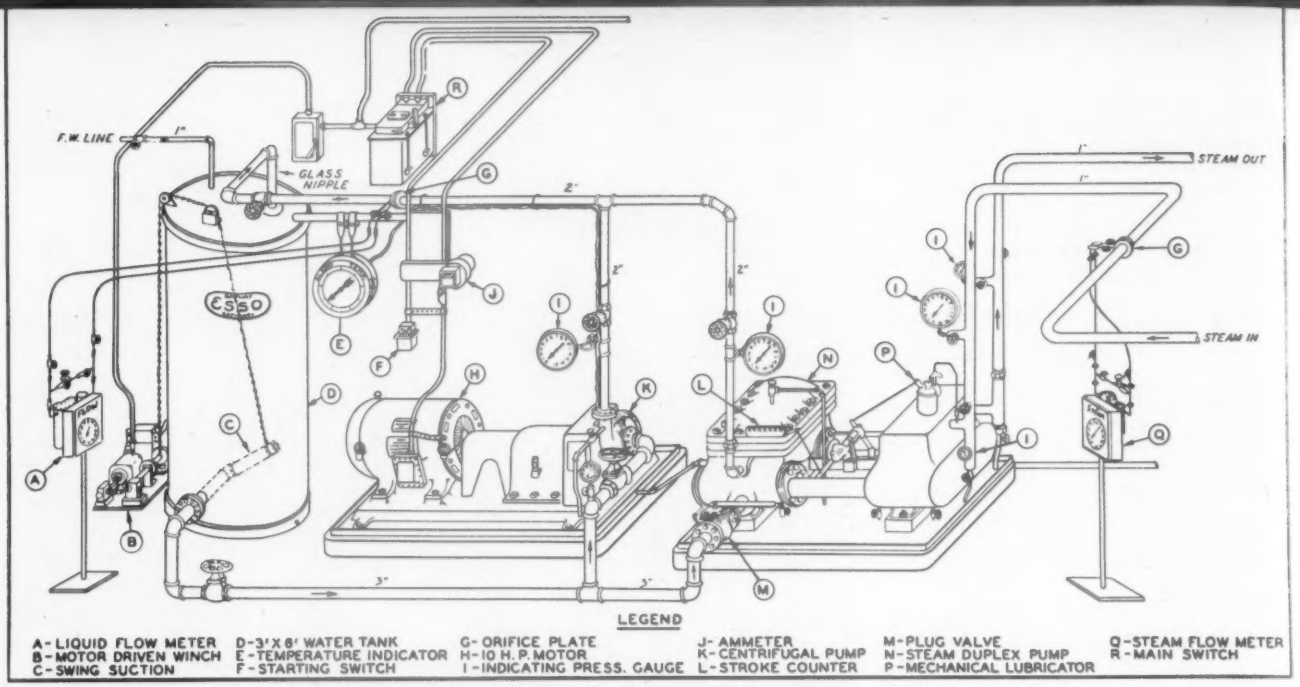


Fig. 1—Diagrammatic piping and instrument layout for equipment installed in Preventive Maintenance Laboratory

7 to 3 shift men attend after leaving the shift and changing clothing, from 3:15 to 4:15 p.m. Process foremen also attend the classes. Transportation is provided for operators located in outlying districts in the refinery. Smoking is permitted to help put the men at ease.

Description of Equipment

The equipment for the preventive maintenance course and its layout in the classroom are shown in Fig. 1. The room is approximately 22 ft wide by 40 ft long, finished with block linoleum flooring and overhead fluorescent lights, and painted in bright, cheerful colors. Lines and pumps are painted with cream, light blue and pale green enamels. Large sized gauges, meters and indicators are used, and are positioned to be seen easily by the members of the group. A large clock equipped with a second hand is used for timing the revolutions of the steam pump.

Operation of the demonstration equipment involves taking suction from the 3 ft by 6 ft tank, which contains fresh water colored with a red dye, and discharging with either pump through the overhead connection back to the tank. Colored water is used in place of gasoline or any other petroleum product as a safety measure. The tank was made from a salvaged section of a stack. Orifice flow meters of the large face indicating type are connected to the live steam supply and to the liquid discharge pipe. Orifice sizes are adjusted to give readings in even hundreds of pounds of steam per hour and even thousands of gallons of liquid flow per hour.

A glass nipple at the end of the discharge line provides a view of the liquid being pumped back into the tank. The tank is covered both to support the swing suction pulleys, and to prevent splashing when demonstrating loss of suction. A motor-driven winch, operating on a 25 to 1 reduction ratio, connected to the internal swing suction, is used to demonstrate the effects of loss of suction.

Bleeder valves, drips and electrical starting equipment follow standard installation practice. A plug valve is located at one point, as shown in the sketch, to demonstrate the correct operating procedure.

The steam pump is a duplex reciprocating pump, size 7½ by 5 by 10, connected to exhaust directly to the air since no exhaust main is located nearby.

The motor pump is a pedestal type centrifugal pump, connected to a 10 HP explosion proof motor. It is rated to deliver 60 GPM at a 75 ft head. Operating speed is 1750 RPM, full load 12.5 amps at 440 volts. An ammeter connected to the motor is used in demonstrating proper and improper operation at starting up and during the operation of this pump. A temperature indicator-recorder shows the temperature at both the pump stuffing box and gland.

Both pumps are mounted on wooden foundations, equipped with drain pans, and designed to simulate actual plant installations as much as possible. Brightly colored lubricant containers, stenciled with the name of the proper lubricants, are located adjacent to the pumps. A large, movable blackboard is used for recording data and instructions.

Third session of the course includes a motion picture on the steam turbine, "The Magic of Steam," purchased from the Allis-Chalmers Mfg. Co. Part I of the film, "The Steam Turbine," is now used. Part II, "The Condenser," has not been used in the course for process operators, but will probably be used in a similar course for steam and power plant operators. The sound projection equipment is of standard 16 mm type.

At the close of the third or final session, a "text book" is distributed. This short, convenient summary of the data presented in the course covers the steps and key points in starting, operating and stopping of steam and motor-driven pumps, and emphasizes the "Care Saves Wear" theme. Printed on a 6½ in. by 5½ in. gray bristol-board, it is laid out to fold in the center, thus providing a size suitable for carrying in a blouse or coat pocket. The men are encouraged to keep this folder in their work clothes, to have it handy for reference if necessary. They are urged to use the stepwise procedure given on the card when breaking in new men.

Employee Reaction

That the plant operators have been applying the information given in the courses is already apparent. Since the completion of the first series of classes on the steam pump, there has been a marked improvement in the operating speed of steam pumps throughout the plant, officials say. This is ascribed to the convincing demonstration of the effect of overspeeding on rate of flow and steam consumption. Very few cracked liquid or steam ends have occurred because of failure to drain out, as compared with previous winter months. Requisitions placed for the proper grade of oil and for proper containers for lubricants again reflect the interest of the men.

Within a week following the motor pump sessions, three instances were reported by the men which resulted in saving serious motor pump failures. Two of these concerned an unusual operating noise, which they had been cautioned to watch for, while the third involved a line wash practice which resulted in a flow back through a pump, causing it to rotate backwards. One of the cases of unusual operating sound revealed that a section of screen had corroded away and fallen into the suction chamber and rested against the impeller. The other disclosed a loosened

impeller nut with the impeller about ready to drop off the shaft.

Most of the time for the first of the three sessions is taken up with discussion of reciprocating steam-driven pumps, and demonstrations on their proper and improper operation.

The importance of starting up a steam-driven pump correctly is stressed, with emphasis on the damage which can be caused by failure to follow the proper procedure. Six starting-up steps are outlined and explained in detail, as follows:

1) Open suction line valve wide and then discharge line valve. The men are cautioned to open both of these valves wide, even though it requires more "elbow grease" to do so, backing them off slightly so that they won't become jammed open and can be shut quickly if necessary. Two reasons are given for opening the valves wide—first to prevent restriction of the line with subsequent energy loss and excess pressure, and second to prevent "wire-drawing" or eroding of the valve gate.

2) Check to see that drips on cylinders and steam chest are open, examine lubrication points and oil moving parts. The drips on the steam chest should have been opened when the pump was last shut down, but in the event they weren't they must be opened before the pump is started again, to remove any water which may have condensed or leaked past the live steam valve. As for lubrication, it is suggested to the men that they remove the cover from the oil chamber for the steam chest and check to see that there actually is oil in the chamber; the glass gauge may have become plugged, giving a faulty indication of the oil level.

3) Open exhaust steam valve. This operation serves two purposes. It drains the exhaust line of any condensate. And exhaust steam running back into the pump (if the exhaust line is connected to the main exhaust system) will serve to heat up the cylinders before starting.

4) Drain live steam line and crack live steam valve. This is necessary to remove all water, which, if allowed to remain in the line, might damage the pump, especially if the throttle valve were opened suddenly.

5) Close drain valve, drips of steam chest, bleeders on cylinders. Before closing the drain valve and drips be sure that dry steam is coming through them, an indication that all water has been removed. It will be necessary to move the piston through one stroke so that the steam can reach both sides of the cylinder.

6) Open throttle valve slowly and bring pump up to speed gradually. Rapid opening of the valve is discouraged, to prevent slugs of water which might possibly still be in the steam line from doing damage, and to allow any trapped air or vapor in the pump to pass out without building up excessive discharge pressure.

First of the four demonstrations with the steam pump is on the effect of overspeeding. The normal impression that most operators seem to have is that by opening up the throttle valve wide and running the pump faster they can pump just that much more product.

The fallacy of this "faster pumping-faster flow" reasoning is strikingly illustrated by first running the pump at normal speed (48 RPM in this case) and noting the steam consumption and rate of flow. These figures are placed on the blackboard, and then the speed of the pump is increased to approximately 60 RPM, the same data being noted.

The steam consumption in pounds per 100 gals. of product pumped is calculated, showing that to gain an increase of only 15% in liquid pumped requires a steam consumption of more than three times that required for normal operation. Typical data from one of these demonstrations are shown in Table 2.

During the demonstration, attention is directed by gestures and pantomime to the change in flow of steam and liquid, and to the noisy "rock crusher" operation, which results in broken springs and studs, bent valve plates, and other damage. Samples of such broken parts are passed around. The group is requested to call to the attention of foremen any pump which requires operation at excessive speed in order to do the required pumping job, since a larger size pump should replace it.

Flow Control at Discharge Valve

The second demonstration is intended to show the effect of throttling back on the discharge valve to control flow, rather than cutting back on the live steam supply. The pump is again operated at normal speed, and the data placed on the board as in the previous demonstration. This repetition of obtaining normal operating data is explained by pointing out that as the pump

The laboratory or "classroom" where Preventive Maintenance courses are held. Classes range in size from 12 to 22. Informal atmosphere is encouraged, smoking permitted. Sessions last one hour, are timed to the minute. Instructor is E. Lehman, foreman of Instrument Dept.

becomes heated up it becomes more efficient and may require less steam.

The discharge valve is then closed down until the flow is reduced to about half the normal rate. At no time during this or any of the other demonstrations is the discharge valve closed entirely while the pump is in operation. If it were, it is pointed out, pressure might be built up far in excess of safe limits, perhaps even sufficient to break some of the fittings or connections.

Again directing the attention of the group to the extreme pounding of the pump, the data for the reduced rate of discharge are placed on the board (Table 3) and the pump shut down. In all demonstrations of improper operation, the pump is operated improperly only long enough to collect the data.

The discussion brings out that the practice of throttling the discharge to control flow results in the same steam consumption per hour as when pumping twice as much liquid. In other words, the unit consumption of steam per 100 gals. pumped is double when operators throttle back in this manner. Again the waste of fuel is brought out, and the group advised to always use the steam throttle valve to reduce liquid flow.

Back Pressure

The effect of increasing back pressure on the exhaust from the pump by not having the exhaust valve wide open is shown in the third demonstration. The pump is adjusted to normal operating speed, and then the exhaust valve is slowly throttled back to 15 lbs back pressure. Typical data for this demonstration are shown in Table 4. In the discussion, after the pump is shut down, it is explained that this demonstration emphasizes the importance of (a) opening the exhaust valve wide at all times, and (b) outporting exhaust at the pump if possible when exhaust steam is being relieved through a main line bleed-off during surplus exhaust steam periods. Again the excess steam consumption is pointed out.

Loss of Suction

The fourth demonstration is concerned with loss of suction. The use of a glass nipple on the return line at the top of the water tank is well adapted to showing the entrainment of air in the liquid, particularly since the water is dyed red. The return water shows up as deep red when no air is present, and as a pink liquid when air is entrained. The group is asked to note this color change, the flow meters, and the performance of the pump as the pump loses suction. After first adjusting the pump to normal speed and taking readings, the swing suction is raised by means of the motor driven winch. In about a half minute the liquid color begins to change, and the liquid flow meter shows a decrease. Steam consumption, meanwhile, remains constant. The pump speeds up to approximately 70 RPM, and the liquid flow stops in about a minute and a half. The winch is then stopped and the pump shut down. Data for this demonstration are given in Table 5.

TABLE 2—Result of Overspeeding Steam Pump

	Speed Revs./Min.	Steam Lbs./Hr.	Flow Gals./Hr.	Pounds Steam/100 Gals.
Normal operation	48	100	2800	3.6
Overspeeding	60	350	3200	10.9
			Steam Wasted	7.3

TABLE 3—Effect of Controlling Flow at Discharge Valve

	Speed Revs./Min.	Steam Lbs./Hr.	Flow Gals./Hr.	Pounds Steam/100 Gals.
Normal operation	48	90	2800	3.2
Discharge valve closed	32	90	1500	6.0
			Steam Wasted	2.8

Shutting Down the Pump

In shutting down the pump the first step, the men are told, is to close off the steam throttle valve and then the exhaust valve, using a wrench only on the larger size valves. The drips on the steam chest are opened to drain off any condensed steam. The drainage is particularly important in cold weather, when accumulated water may freeze and crack the cylinders. Another reason for opening the drips is to detect leakage through the live steam valve because of worn seats. Any such leakage should be reported at once, since it is necessary to change valve discs from time to time, and detecting leaky valves early can save a tremendous amount of steam—and fuel.

Finally, the suction and discharge valves are closed tight, and the sample bleeder opened to bleed off any pressure.

In concluding the first session, the instructor tells the men that "you don't have to wait for any special instructions to start preventive maintenance right now. Do it at once, get into the swing of it, help us keep abreast of our war job."

Motor-Driven Pumps

The second session, after a brief review of the objectives of the course and of the material covered in the first session on the steam pumps, deals entirely with motor-driven centrifugal pumps, which are coming more and more to replace steam pumps. At the Bayway refinery alone there are 1280 centrifugal pumps, some motor-driven and some turbine-driven.

With the steam pump it was emphasized that more things could happen to it while it was being operated. In the case of the motor-driven centrifugal pump, however, the starting-up period is the most critical, during which more things can happen than under any other conditions. Therefore, most attention is paid to the proper starting procedure. Four main steps in starting up a motor-driven pump are outlined at this point:

(1) Check lubrication, close main switch, and see that discharge valve is not open. Starting the pump up with the discharge valve open overloads the motor, and may result in burned out windings. The one exception is when starting up pumps that have a large discharge valve—above 10 in., in which cases the valve may have to be cracked open very slightly.

(2) Open the suction valve and bleed it to be sure that there is liquid in the pump. Air or vapor trapped in the pump will result in an unbalanced condition, with the impeller pumping air in one section and liquid in another.

(3) Press down the starter button. If the motor doesn't start up at once don't hold the button down more than a few seconds. And don't try the starter more than two or three times. Otherwise the starter switch contacts may become badly pitted.

(4) Open the discharge valve slowly, as soon as the motor is up to speed.

Starting Difficulties

If the motor won't start, it may be that no power is available. Check the main switch. If the motor is slow to get up speed (over 10 seconds) check to see if the discharge valve is open. Another explanation may be that an excessively large impeller has been put in the pump, causing overload, or that a change has been made in the product. Tight packing may also make the motor slow to get up speed.

If the motor trips off continuously in starting, don't attempt to start it more than two or three times. The starting current is 7 to 10 times the safe operating amount, and, if applied too many times at close intervals, the motor windings will heat up and eventually burn out.

The attention of the group is directed to the "whistle" which the motor makes when started. They are then cautioned to look out for a "hum," which usually

TABLE 4—Effect of Back Pressure on Exhaust

Back Pressure	Speed Rev./Min.	Steam Lbs./Hr.	Flow Gals./Hr.	Pounds Steam/100 Gals.
0	48	90	2800	3.2
15	..	90	1200	8.3

TABLE 5—Loss of Suction

	Speed Rev./Min.	Steam Lbs./Hr.	Flow Gals./Hr.	Pounds Steam/100 Gals.
Normal suction	48	80	2800	2.8
No suction	72	80	0	..

indicates seizure somewhere in the pump—impeller obstruction, tight packing, freeze-up, locked bearings.

Any noises different from the customary smooth-running sound of motor-driven equipment are warning signals that something is not correct and requires attention. To demonstrate an example of a noise to watch for, the suction valve is throttled about two or three turns. A rumbling, "bumping" sound, the result of poor suction, occurs, and its effect on pump wear is described to the group. Bearing noise is demonstrated by rotating a new bearing, and then rotating a worn bearing, noting the sound in each case.

Starting With Discharge Valve Open

After reviewing the proper starting procedure, the pump is started in the correct manner, with the discharge valve closed, and the attention of the group is directed to the deflection of the ammeter needle—65 amps, returning to 0 and then increasing to 12.5 amps (normal load) when the discharge valve is opened. The pump is shut down, and then, with the discharge valve open, started up again. This time the ammeter needle jumps up to 85 amps, returning to 0 as before and increasing to 12.5 amps. under normal load.

The effect of this increased amperage at the start is overheating of the windings of the motor, ultimately causing their failure.

Another difficulty may develop if the pump is started up with the discharge valve open. The check valve in the line may not hold, permitting liquid to flow backwards in the discharge line and causing the pump to rotate in the opposite direction. If the pump is then started while it is rotating backwards, the entire pump and motor may be wrecked, with impeller blades broken off and the shaft twisted. Even with the discharge valve closed, it is wise to check and see that the pump is not rotating in the wrong direction (even slowly) before pressing the starter button. There may be a leak in the valve.

Loss of Suction

To demonstrate the effect of losing suction, the swing suction is elevated while the pump is in operation, and attention directed to the flow-meter, discharge outlet, fluctuating pressure gauge, rumbling noises and ammeter. Particular emphasis is placed on the noise, the value of the pressure gauge in indicating the performance of the pump, and the widely fluctuating ammeter needle. The unbalanced condition reflected by both the pressure gauge and the ammeter is discussed, using a large cross sectional drawing of the pump.

The proper method of starting up the pump after losing suction involves basically the procedure to be followed when starting up the motor in the first place—primarily opening the suction valve and then bleeding the pump until liquid is expelled, indicating that all the gas or vapor is removed from the pump.

Extreme care in adjusting packing on motor-driven pumps to stop leakage is necessary. "Feel" and good judgment are required; once the packing is adjusted too tightly the damage is done. The main point is to pull up the studs evenly, one flat at a time.

To demonstrate the effects of improperly pulling up on the gland, attention is called to the temperature recorder reading—approximately 75°F., and to the normal load of 12.5 amps. on the motor. The gland studs are then tightened and the ammeter load noted. After several turns (usually 3 to 3½) the load increases from 65 to 69 amps. And within several minutes the gland and stuffing box temperature increases to 120°F., an increase of nearly 50° in several minutes. The gland bolts are quickly loosened and the gland backed off. It is then explained that the increase of 4 amperes additional current is just so much energy being used to score the sleeve. No change in flow is indicated on the flow meter. A "scored" sleeve, the result of improper gland adjustment, is exhibited and compared with a new sleeve of the same type.

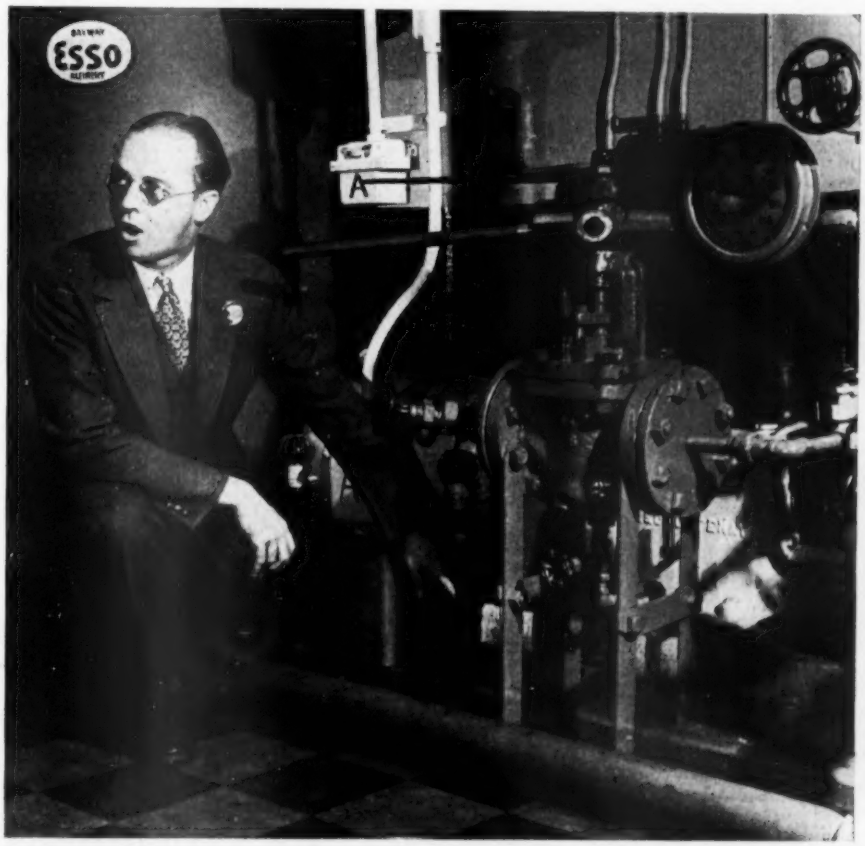
Stopping the motor-driven pump involves just the reverse of the starting operations—close discharge valve, press down on the stop button, close suction valve. If the motor doesn't stop running, it can be stopped by pulling the main switch. The men are warned, however, to use this main switch only in emergencies, and to pull it quickly so that arcs do not ruin the contacts.

Third and final session of the course includes the steam turbine movie previously mentioned, in addition to very brief discussions of other operating equipment—emergency lighting units, plug valves, oil losses. Time is allowed toward the close of this session for discussion of the material covered in the previous sessions on pumps, and for any questions the men may have.

Additional Courses

Two ideas are at present being considered by Standard for expansion of the Preventive Maintenance course. One of these consists of combining all three sessions into one "refresher" course. This condensed review would probably be given once a year to those who had previously been through the entire program, and would more than likely be presented in the fall, with emphasis being placed on cold weather care.

Consideration has also been given to the extension of preventive maintenance courses to lower level process operators, fire department personnel, tank cleaners who operate pumps and steam and power plant operators. Although one group of field machinists has already had the present course, some thought has been given to developing a separate course for them.



Last session includes material on valves. Proper and improper operation of Homestead plug valve is being demonstrated by Instructor A. S. Taylor, asst. head of Atmospheric Distallation Dept.

NEW TESTS DETERMINE METALS IN LUBRICANTS

Originating as Wartime Standards to Identify Metals and Other Inorganic Elements in Additive-Type Oils, These Methods May Also Be Useful to Refiners as Controls in Manufacturing

METHODS of test to determine the amounts of metals and other inorganic elements in lubricants have been developed by a special subcommittee of Committee D-2 on Petroleum Products and Lubricants of the American Society for Testing Materials. The program took three years of intensive work by a small group of chemists and engineers.

These methods provide a means for calculating within a reasonable degree of accuracy the amounts of substances—as small perhaps as one part in a million—in a conglomeration of as many as 14 different metals and inorganic elements in a sample of lubricating oil. The tests can be worked by regular laboratory technicians and can be reproduced uniformly in different laboratories.

The tests were originally developed to provide a means of identification of metal-type additives in new and used lubricants, and their value for this purpose is widely recognized. However, they are also already being put to use as control methods in at least one refinery to check the additive make-up of finished products.

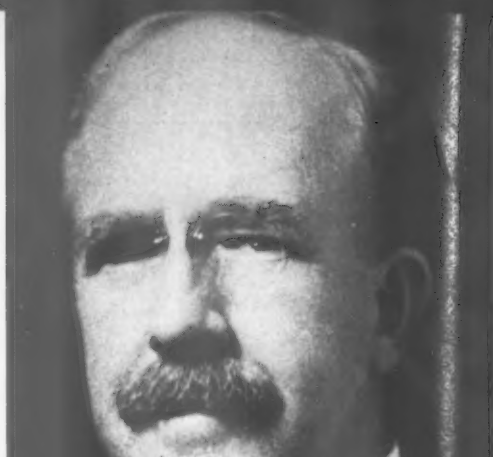
The completion of the work of developing the test methods was reported at the recent meeting of the A.S.T.M. in New York, June 26-30. Raymond Haskell, consulting engineer for The Texas Co., is chairman of the group of technologists engaged on this project, officially designated as Subcommittee XI (of Committee D-2) on Inorganic Elements in Lubricants.

However, at the urgent request of Army authorities, the methods were issued March 21 by the A.S.T.M. as Emergency Standards, to provide for their actual use at as early a date as possible. They will probably be proposed later as regular standard A.S.T.M. test methods.

Their promulgation as emergency methods is the outcome of a request several months ago by the Army to Dr. Haskell's group to speed up its work. The need in Army laboratories and testing grounds for uniform methods for determining the amounts of metals and other inorganic substances in motor oils, gear oils and other lubricants, was pointed out. Such methods, it was stated, must be uniform with those used in oil company and automotive laboratories.

These tests, for example, provide a means for checking the amounts of metal-type additives which are used in the heavy-duty engine oils and gear lubricants now widely adopted for Army ground automotive equipment.

In used oils, by these methods, the amounts of the additives remaining in the lubricants after various periods of use can be determined. They also provide a means for showing the amounts of lead, copper, iron and other metals which become a contaminant of the lubricant through wear of bearings and other parts. The new tests will prove equally valuable in checking industrial lubricants containing metal-type additives, or oils subject to contamination by metal parts.



Raymond Haskell, New York, consulting engineer, The Texas Co., chairman of the group of technologists who developed the methods of test to measure the amounts of inorganic elements in new and used lubricating oils

The new methods cover sulfur, chlorine, phosphorus, lead, copper, iron, barium, aluminum, calcium, magnesium, zinc, tin and silicon. The test for sulfur is a revision of the A.S.T.M. standard bomb method of test for sulfur in petroleum oils and is entitled Emergency Alternate Provisions in Standard Method of Test for Sulfur in Petroleum Oils by Bomb Method (EA-D129). The revision was required for lubricating oils, to provide a method of test where the presence of other inorganic substances would not interfere with the accuracy of the determination for sulfur. Four of the test methods are entirely new. They are:

Emergency Method of Test for Chlorine in Lubricating Oils by Bomb Method (ES-36).

Emergency Method of Chemical Analysis for Phosphorus in Lubricating Oils (ES-37).

Emergency Methods of Chemical Analysis for Lead, Copper, and Iron in Lubricating Oils (ES-38).

Emergency Methods for Chemical Analysis of Metals in Lubricating Oils (ES-39).

The original project was to develop methods for measuring the amounts of metal-type additives in hypoid gear lubricants and Dr. Haskell's group started out with the title of Subcommittee XI on Determination of Sulfur, Chlorine and Phosphorus in EP lubricants. A wider scope for the program soon was seen, however, and the title was changed to Determination of Inorganic Elements in Lubricants.

The chemists and engineers enrolled

The Men Who Did the Work on the New Test Methods

The work of developing methods of test to determine metals and other inorganic elements in lubricants was divided into five projects, carried out by the following five subcommittees:

On sulfur, C. A. Neusbaum, Standard Oil Development Co., chairman.
On phosphorus, L. Lykken, Shell Development Co., chairman.
On chlorine, Mr. Neusbaum, chairman.
On lead, copper and iron, C. M. Gambrill, Ethyl Corp., chairman.
On other metals, Mr. Gambrill, chairman.

The membership of the main Sub-committee XI on Inorganic Elements in Lubricants, of Committee D-2 of A.S.T.M. is as follows:

Raymond Haskell, The Texas Co., chairman.

O. C. Bridgeman, National Bureau of Standards; L. L. Davis, Continental Oil Co.; A. E. Flowers, The DeLaval Separator Co.; C. M. Gambrill, Ethyl Corp.; N. J. Gothard, Sinclair Refining Co.; P. F. Kondla, Pratt & Whitney;

Harry Levin, The Texas Co.; L. Lykken, Shell Development Co.; O. L. Maag, Timken Roller Bearing Co.; J. L. McCloud, Ford Motor Co.; C. A. Neusbaum, Standard Oil Development Co.; W. H. Oldacre, D. A. Stuart & Co.;

C. F. Ramey, Standard Oil Co. of California; E. P. Rittershausen, Socony-Vacuum Oil Co., Inc.; E. W. Upham, Chrysler Corp.; A. O. Willey, The Lubri-Zol Corp.; N. D. Williams, The Pure Oil Co.; H. R. Wolf, Research Laboratories Division, General Motors Corp.

in the work have been beset with unusual difficulties, due to the press of other wartime duties as well as the magnitude of the task assigned them. In spite of this, deadlines for reports have been scrupulously met. Women chemists and laboratory technicians have been used and members of the various committees have donated much of their own time to the work.

The program was speeded up by careful avoidance of duplicating any development work. When it was found that one or more oil or automotive laboratories had already worked out a practical method for some step required in the program it was adopted by the committee and incorporated in the emergency program.

Following are summaries of the one emergency alternate provision and the four new emergency methods for determining metals and other inorganic elements in lubricating oils; also given are abbreviated forms of tables from the current report of Committee D-2 to the A.S.T.M., showing the results of co-operative determinations by these various methods:

Sulfur

Emergency Alternate Provision EA-D-129 for A.S.T.M. Standard Method of Test for Sulfur in Petroleum Oils by Bomb Method (D-129-39).

Changes in the standard method to make it applicable to determination of sulfur in lubricants containing additives are as follows:

Sect. 1 (Scope of Method)—changed to read: "This method of test covers the procedure for determining sulfur in used and unused motor oils containing additives."

Sect. 3—(Special Solutions Required)—changed as follows to add sodium carbonate solution to the list of reagents required in the test: "(e) Sodium Carbonate Solution (0.2 N)"

Sect. 4 (a)—(Procedure)—changed to make the second paragraph read: "Add to the bomb 25ml of the sodium carbonate solution (0.2 N) and rotate the bomb in such a manner that the walls are moistened by the solution."

Sect. 6—(Reproducibility of Results)—changed to read: "Results obtained by different operators in different laboratories should not differ by more than the following:

Sulfur Content, %	Permissible Difference
0 to 0.5	±0.03
Over 0.5 to 1.0	±0.04
Over 1.0 to 2.0	±0.05

Table 1—Results of Co-operative Determinations of Sulfur by Emergency Method EA-D-129†

(Eight laboratories participating)

	Sulfur, %			
	Sample S-20	Sample S-21	Sample S-22	Sample S-23
Average of results	0.53	0.39	1.98	2.06
Average deviation	0.016	0.037	0.05	0.019
Maximum deviation	0.03	+0.07	—0.11	—0.06
Percentage present	0.54	0.44	1.96	2.00

†All results are averages of two or more individual determinations.

Table 2—Results of Co-operative Determination of Chlorine by Emergency Method ES-36*

(Eight laboratories participating)

	Chlorine, %			
	Sample S-20	Sample S-21	Sample S-22	Sample S-23
Average of results	1.97	0.32	0.38	1.95
Average deviation	0.049	0.029	0.039	0.044
Maximum deviation	+0.11	+0.06	+0.08	+0.14
Percentage present	2.04	0.31	0.30	1.92

*All results are averages of two or more individual determinations.

Table 1 shows the results of co-operative determinations of sulfur by the Emergency Method EA-D129.

Chlorine

Emergency Method ES-36 for Chlorine in Lubricating Oils by Bomb Method.

The outline of test procedure states that with this method satisfactory results have been obtained on oils containing as little as 0.1% chlorine.

The procedure calls for the release of the chlorine in the sample of oil by combustion with oxygen in the bomb and its absorption by a Na_2Co_3 solution. The chlorine is then determined volumetrically by titration with $AgNO_3$ or gravimetrically by precipitation as AgCl.

The method states that results obtained by different laboratories should not vary by more than:

Chlorine Content, %	Permissible Difference
0 to 0.5	±0.03
Over 0.5 to 1.0	±0.04
Over 1.0 to 2.0	±0.05

Table 2 shows the results of co-operative determinations of chlorine by eight laboratories by this emergency method.

Phosphorus

Emergency Method ES-37 of Chemical Analysis for Phosphorus in Lubricating Oils.

The test procedure states this method of chemical analysis is intended for the determination of phosphorus in new and used lubricating oils containing 0.001 to 0.5% of phosphorus. It is not applicable to a few organic derivatives of phosphorus. Lead, iron, copper, calcium, barium, sulfur and chlorine, often present as impurities or additives in lubricating oils, do not interfere in the method. A note states:

"This method is also applicable, but with somewhat less accuracy, to the determination of the phosphorus content of lubricating oil additives. In this case the phosphorus content must be lowered by dissolving the additive in phosphorus-free oil, so that the percentage of phosphorus in the resulting mixture is in the range of 0.001 to 0.1.

In the test procedure the sample, mixed with sufficient oil to give a mixture the content of which is below 0.1%, is mixed with Na_2O_2 and ZnO. The mixture is heated to 100°C, benzene is added, and the resulting mixture allowed to burn. After removal of the residual carbon by ignition, the residue is dissolved in acid, the phosphorus precipitated as the phosphomolybdate and the precipitate titrated acidimetrically.

Results should not differ from the mean by more than:

Phosphorus Content, %	Same Operator and Apparatus	Different Operator and Apparatus
Under 0.01	±0.0005	±0.001
0.01 to 0.07	±0.001	±0.002
Over 0.007 to 0.35	±0.003	±0.006
Over 0.35 to 0.5	±0.01	±0.02

Table 3 gives the results of co-operative tests for phosphorus by this method

Table 3—Results of Co-Operative Determinations of Phosphorus by Emergency Method ES-37

(Six laboratories participating)

	Phosphorus, per cent												
Sample	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-20	S-21	S-22	S-23
Average of Results	0.0012	0.092	0.152	0.036	0.078	0.068	....	....	....	0.197	0.114	0.431	0.396
Average Deviation	0.00025	0.0013	0.003	0.0035	0.007	0.0015	....	....	....	0.0017	0.0048	0.007	0.0027
Maximum Deviation	.....	—0.0026	....	+0.007	....	—0.003	....	....	....	+0.003	—0.008	—0.0011	+0.004
Percentage Present	0.001	0.090	0.150	....	0.070	0.070	0.201	0.099	0.667	0.199	0.117	0.42	0.407

in which six laboratories participated.

Lead, Copper, Iron

Emergency Method ES-38 for Chemical Analysis for Lead, Copper and Iron in Lubricating Oils.

The presence of other metallic elements, sulfur, chlorine and phosphorus in the amounts commonly found in lubricating oils does not interfere in this test, the outline of the method states.

The principle of the test procedure is outlined briefly as follows:

"(a) the sample is completely oxidized by wet ashing with H_2SO_4, HNO_3, and H_2O_2, or, if only iron and copper are to be determined, by dry ashing.

"(b) The solution resulting from the wet ashing is mixed with alcohol and filtered and the precipitate (lead sulfate and any other insoluble sulfates) transposed by boiling with Na_2CO_3 solution to remove sulfate ion. After solution of the carbonates, lead is precipitated with H_2S and determined by weighing as the sulfate.

"(c) Iron and copper are determined on separate aliquots of the filtrate from the wet ashing or of the acid solution of the dry ash. Iron is determined by separating as the hydroxide and determining colorimetrically as the orange ferrous ortho-phenanthroline complex; copper is determined colorimetrically as the yellow diethyldithiocarbamate complex."

Results should not differ from the mean by more than the following:

	Same Operator and Apparatus	Different Operators and Apparatus
Lead Content		
Under 1%	0.01	0.02
1% or over	1% of mean	2% of mean
Iron or Copper Content		
Under 0.01%	0.001	0.002
0.01 to 0.1%	0.005	0.010
Over 0.1%	5% of mean	10% of mean

Table 4 gives the results of tests by seven laboratories under this method for determination of lead, iron and copper in lubricating oils.

Other Metals

Emergency Method ES-39 for Chemical Analysis for Metals Other than Lead, Copper and Iron in Lubricating Oils.

These methods of chemical analysis are intended for the determination of barium, tin, silica, zinc, aluminum, calcium, magnesium and sodium and potassium in new and used oils. The presence of other metallic elements, sulfur, phosphorus and chlorine in amounts commonly found in lubricating oils does not interfere in the method.

The principle of the method of test is described as follows:

"(a) The analytical procedures follow the well-known scheme of separating the metals into groups for more convenient determination. This scheme provides a rapid and accurate method for the determination of all, several, or any one of the metals as may be seen necessary from an initial qualitative inspection of the old sample.

"(b) To avoid its interference throughout the procedure, barium is separated along with the metals of the hydrogen sulfide group. The 8-hydroxyquinoline serves as an excellent means for removing iron, aluminum and zinc from phosphate interference. Phosphate and sulfate ions are removed after the calcium determination to provide for a more accurate determination of sodium and potassium."

Table 5 gives results of tests in which five laboratories participated for chemical analysis of metals in oils.

Table 4—Results of Co-operative Determinations of Lead, Iron and Copper By Emergency Method ES-38

(Seven laboratories participating)

	Lead, per cent	Iron, per cent		Copper, per cent		
	Wet Ash	Wet Ash	Dry Ash	Wet Ash	Dry Ash	
Sample S-7						
Average of Results	0.54	0.009	0.011	0.004	0.001	0.001
Avg. Deviation	0.08	0.0017	0.0003	0.003	0.000	0.000
Max. Deviation	+0.20	—0.003	—0.001	+0.008	0.000	0.000
% Present	0.542	0.010	0.010	0.001	0.001	0.001
Sample S-8						
Average of Results	0.95	0.093	0.098	0.011	0.009	0.010
Average Deviation	0.04	0.007	0.001	0.003	....	....
Maximum Deviation	+0.009	—0.021	+0.002	—0.006	....	....
% Present	1.001	0.100	0.100	0.011	0.011	0.011
Sample S-9						
Average of Results	0.489	0.081	0.081	0.010	0.007	0.010
Average Deviation	0.053	0.012	0.001	0.002	0.002	....
Maximum Deviation	+0.091	—0.027	—0.002	—0.006	—0.003	....
% Present	0.502	0.088	0.088	0.011	0.011	0.011

How to Secure Copies of the New Tests for Metals in Oils

Official designations of the A.S.T.M. Emergency Methods for determination of metals and inorganic elements in lubricating oils are:

Emergency Alternate Provisions in Standard Method of Test for Sulfur in Petroleum Oils by Bomb Method (EA-D129).

Emergency Method of Test for Chlorine in Lubricating Oils by Bomb Method (ES-36).

Emergency Method of Chemical Analysis for Phosphorus in Lubricating Oils (ES-37).

Emergency Methods of Chemical Analysis for Lead, Copper and Iron in Lubricating Oils (ES-38).

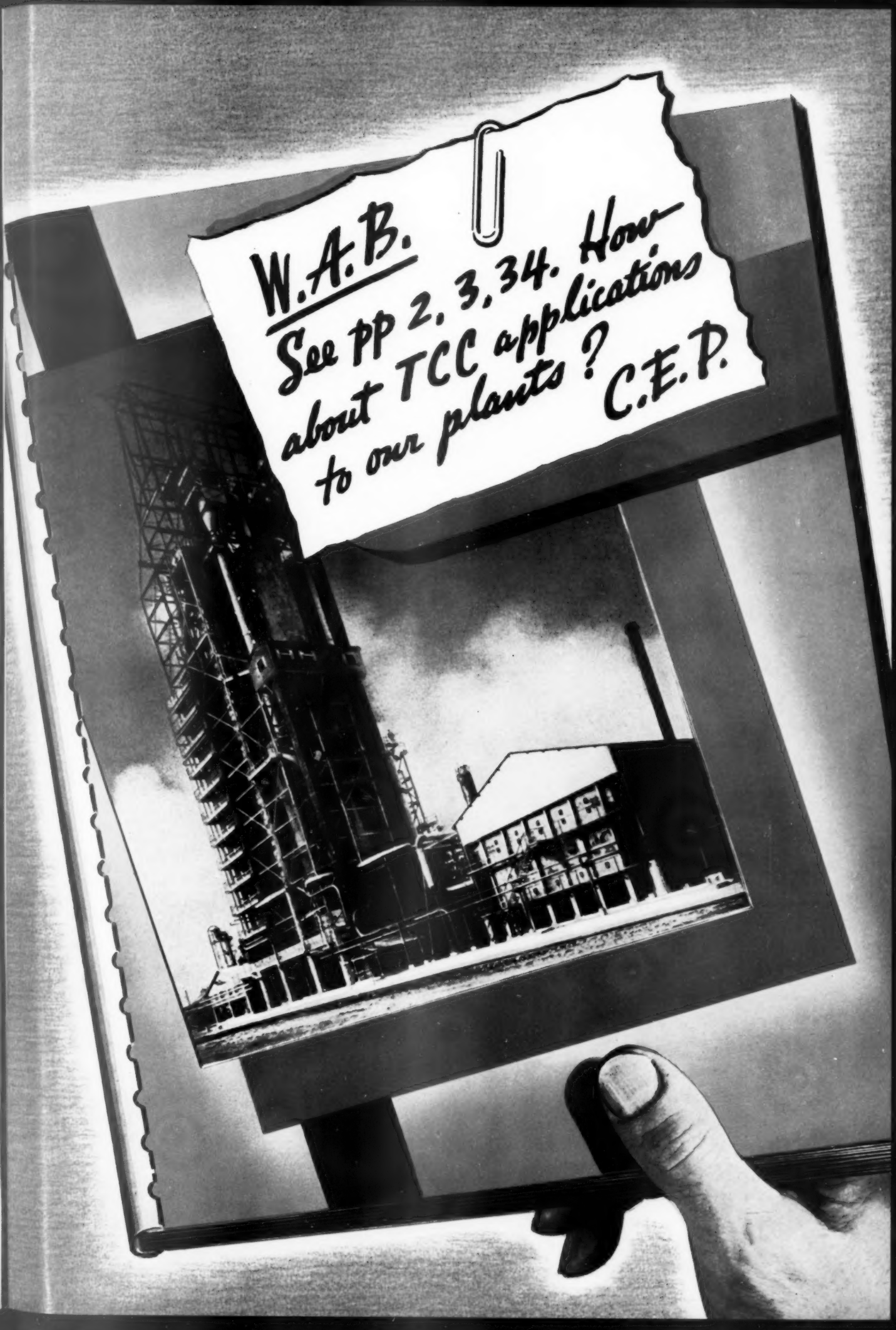
Emergency Methods for Chemical Analysis of Metals in Lubricating Oils (ES-39).

Copies of these test methods can be had by writing the American Society for Testing Materials, 260 S. Broad St., Philadelphia 2, Pa.

Table 5—Results of Co-operative Determinations of Barium, Aluminum, Calcium, Magnesium, Zinc, Tin and Silicon by Emergency Method ES-39

(Five laboratories participating)

	Sample S-8			Sample S-9						
	Barium, per cent	Aluminum, per cent	Calcium, per cent	Barium, per cent	Aluminum, per cent	Calcium, per cent	Magnesium, per cent	Zinc, per cent	Tin, per cent	Silicon, per cent
Average of Results	0.263	0.053	0.099	0.286	0.060	0.201	0.195	0.520	0.232	0.047
Average Deviation	0.017	0.013	0.011	0.003	0.021	0.004	0.010	0.108	0.007	0.020
Maximum Deviation	—0.040	—0.018	+0.026	+0.007	+0.044	—0.007	+0.015	+0.26	+0.008	+0.041
Percentage Present	0.297	0.069	0.100	0.297	0.075	0.198	0.197	0.494	0.247	0.030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PETROLEUM REFINING PLANTS

Wider Use of Pilot Plants Required in Modern Refinery

Greater Number of Variables, Need for Closer Control Increase Usefulness of "Small Scale" Operations In Predicting Performance of Refining Processes

By Louis C. Rubin and John S. Rearick***

The advent of catalytic cracking and other new processes has given impetus to the development and use of pilot plants by oil companies. The three principal uses of this apparatus are for investigation of new processes, to evaluate the adaptation of known processes to a given refinery unit and to pilot the operations of an existing unit. Main requirements in design and engineering of these three types are described. In addition, operating problems common to pilot plants in general are briefly discussed.

PILOT PLANTS for control and development work in the field of petroleum technology have assumed continually increasing importance during the past 15 or 20 years. The present state of development of this field of engineering is exemplified by the tremendous expansion of the 100-octane production facilities in the past few years. Many of the design data for these plants were obtained on pilot plants and today these same pilot plants are guiding the operations of the full scale plants. Future developments will undoubtedly require that pilot plant engineering continue to play an ever increasingly important part.

Although much of the early work on pilot plant scale was devoted to thermal operations, the advent of catalytic refining processes gave a tremendous impetus to pilot plant developments. The greater number of variables and the necessity for close control of these processes have led to the creation of pilot plants whose control equipment rivals that of the full scale plants.

Perhaps at this point the question should be raised, "Just what is a pilot plant?" It might broadly be defined as a collection of process equipment designed to duplicate on a small scale the operating conditions, known or anticipated, and performance of a full scale unit.

More specifically for the purpose of this discussion, it is apparatus for carrying out (usually on a continuous basis) a petroleum refining process on a scale of from a tenth to ten barrels per day. These figures have been chosen arbitrarily but equipment of smaller capacity than this is generally considered "bench scale", while larger plants approach "semi-commercial" operation.

In general, the pilot plant is built for one of the following purposes: To investigate new processes, to evaluate the adaptation of known processes to a given refinery setup, or to pilot the operations of an existing refinery unit. Each of the foregoing imposes certain limitations on pilot plant design.

In the case of a plant built for the study of a new process, since little is known regarding the process or the optimum conditions for carrying it out, it is essential that the pilot plant be designed for a maximum degree of flexibility and that it be made as simple as possible and still carry out its desired function.

In many instances, it will prove desirable to carry the process out in stages. This is a very common procedure in the chemical industry, where a process may be split up into unit operations and the experimental work on each be carried out separately. This procedure offers the advantage of simplicity and makes it possible to vary the scale of the different operations.

In many cases a plant for studying new processes represents at best an educated guess as to how the process might be carried out. The designer should be prepared to redesign and re-

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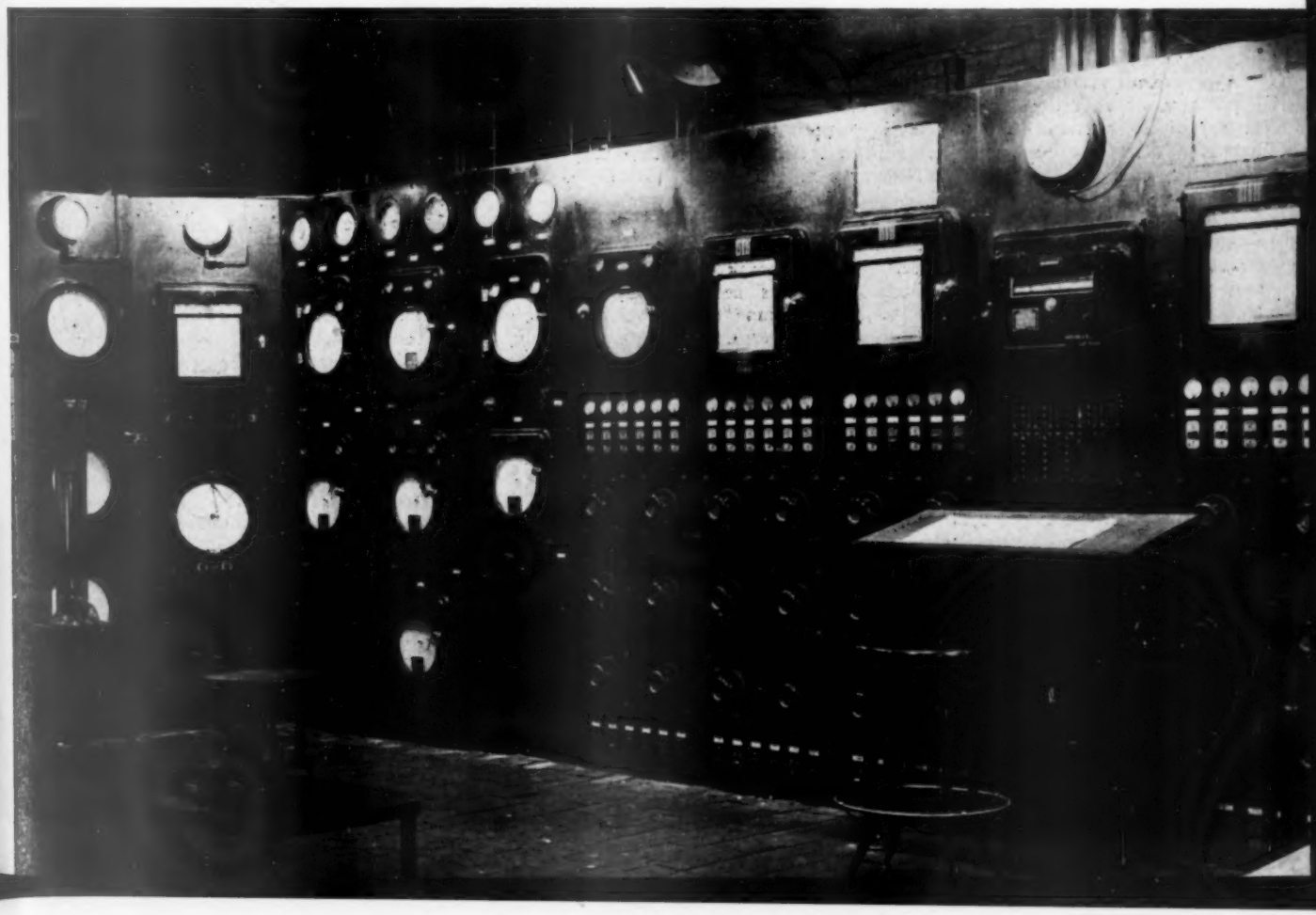
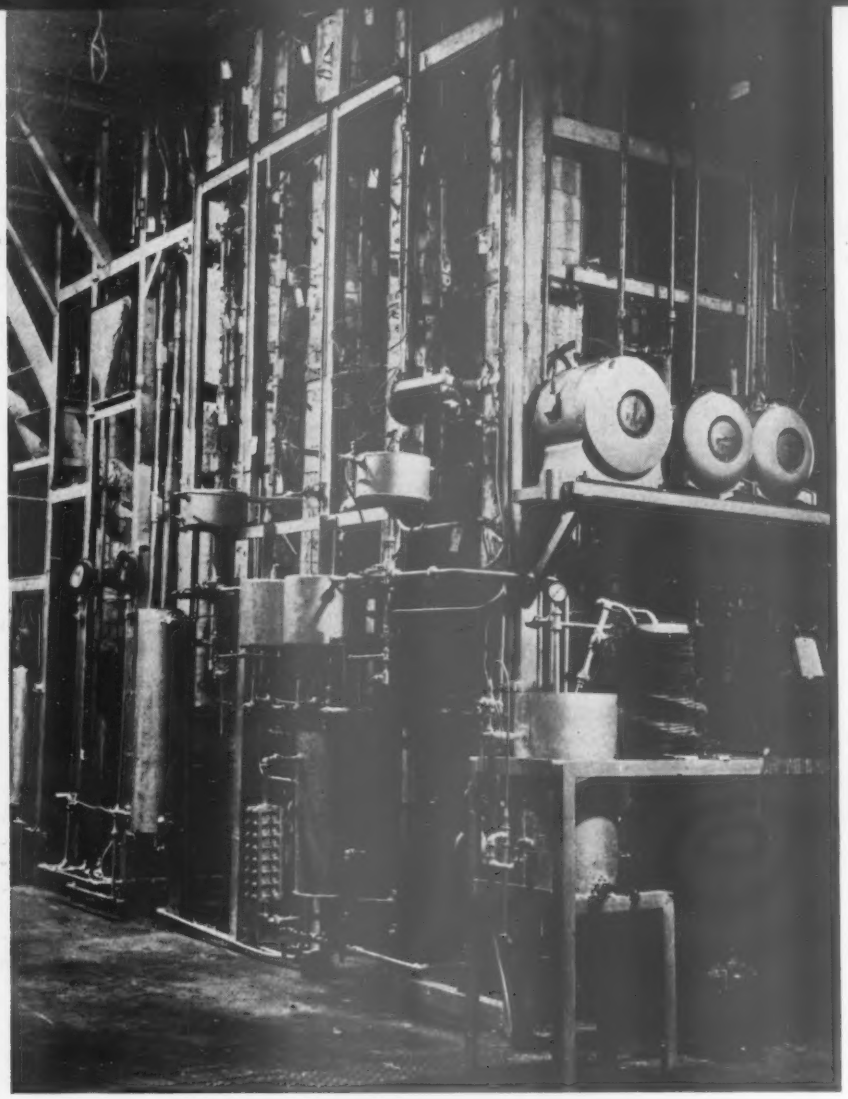


Even though the throughput in a pilot plant is small (less than 10 b/d) adequate recording and control instruments are essential. The above view shows only part of the control board for a Fluid Catalytic Cracking pilot plant



A hydroforming pilot plant

build the plant as many times as may prove necessary as he gains more knowledge regarding the process.

A pilot plant intended to evaluate the application of an existing process to a given refinery situation and to furnish data for design of equipment should also embody a maximum degree of flexibility. Generally speaking, however, certain limitations both from a process and a mechanical standpoint will have been established here and the designer should keep them in mind. On the other hand, he should not allow such limitations to blind him to possible innovations or improvements. Frequently for this purpose it is desirable to operate the pilot plant as an integrated unit, although this is not necessarily the case. It is of the utmost importance that the pilot plant give results that correlate well with large scale operations; otherwise, the data obtained will be of little practical value.

In the case of a pilot plant to guide the operations of a particular refinery unit, the ideal is an exact miniature of that plant. Unfortunately, it is never possible to scale a large plant down directly. Some compromise is always involved. But, in general, good design plus good operation will produce results in excellent agreement with those obtained on the full scale unit. In this case there is no particular necessity for designing the pilot plant to operate over wider ranges of conditions than can be obtained on the large unit. It is neither necessary nor desirable, for example, to design the fractionation system to give a better separation than that which can be obtained on the large plant.

Basis for Design Important

In the design of a pilot plant, as mentioned previously, some compromise is always necessary and one question which immediately faces the designer is what basis shall be selected. Should a certain vessel be designed with the same ratio of height to diameter as the larger vessel which it is intended to duplicate or should it be designed to give under equivalent operating conditions a comparable linear velocity, or an equal pressure drop?

In addition to the foregoing, there are other bases which may be selected, but each problem must be studied individually. This phase of the work calls for the greatest exercise of judgment on the part of the designing engineer. Many times it will prove necessary to use different bases in designing different parts of the same unit, since too rigid an application of one basis may result in equipment that is inoperable.

Another question that is closely allied with the foregoing is the size of the plant. Generally, it is desirable to build the plant as small as possible and still have good operability and obtain dependable results. Other considerations that arise are the availability of feed stock for the pilot plant and the disposal of products from it. These may, in certain cases, have a very great influence on the choice of size, as in the case of a topping unit designed to prepare feed stock for other pilot plant operations.

Invariably when operating small scale equipment at elevated temperatures, it is necessary to compensate for heat losses. For the temperature ranges ordinarily encountered, general practice is to employ electrical resistance heaters controlled by rheostats or, preferably, variable transformers. There are numerous different methods of installing such heaters on vessels and lines, including prefabricated heaters of various shapes, clamped, bolted or welded to the wall of the vessel, bare wire heaters wound over insulation, or wire heaters insulated with asbestos or ceramic beads wound directly on the vessel itself. The particular type of installation chosen is largely a matter of preference weighted by such factors as temperature level and degree of uniformity of heat input required.

The various items of pilot plant equipment may be separated into a number of general classifications. Heating and cooling equipment is one of the most important of these subdivisions, since a great majority of petroleum refining processes are carried out at elevated temperatures. In the case of thermal cracking work the design of heating equipment is particularly important, since here it is desirable to duplicate the temperature gradient which will be obtained in a large furnace. This is an exceedingly difficult problem, due to the fact that the surface to volume ratio for small tubes is much different from those employed in commercial practice, and also because it is generally impossible to obtain vapor and liquid velocities in such heaters which approach those of the full scale furnace. One of the most satisfactory solutions to this problem has been the use of heating coils connected in series and immersed in molten lead or salt baths at various controlled temperature levels.

With relatively few exceptions, the design of cooling equipment is much less critical than that of heaters. Simple jacketed pipes or coils in water boxes are adequate for the most part. Heat exchange is rarely employed on pilot plants since it usually only complicates the operation and limits the flexibility of the plant.

Reaction chambers, in the case of catalytic operations, are frequently the most important items in the plant and particular care must be taken to insure that they will give results equivalent to those obtained on a large scale. For endothermic and exothermic processes, it is generally desirable to design such chambers for as nearly adiabatic opera-

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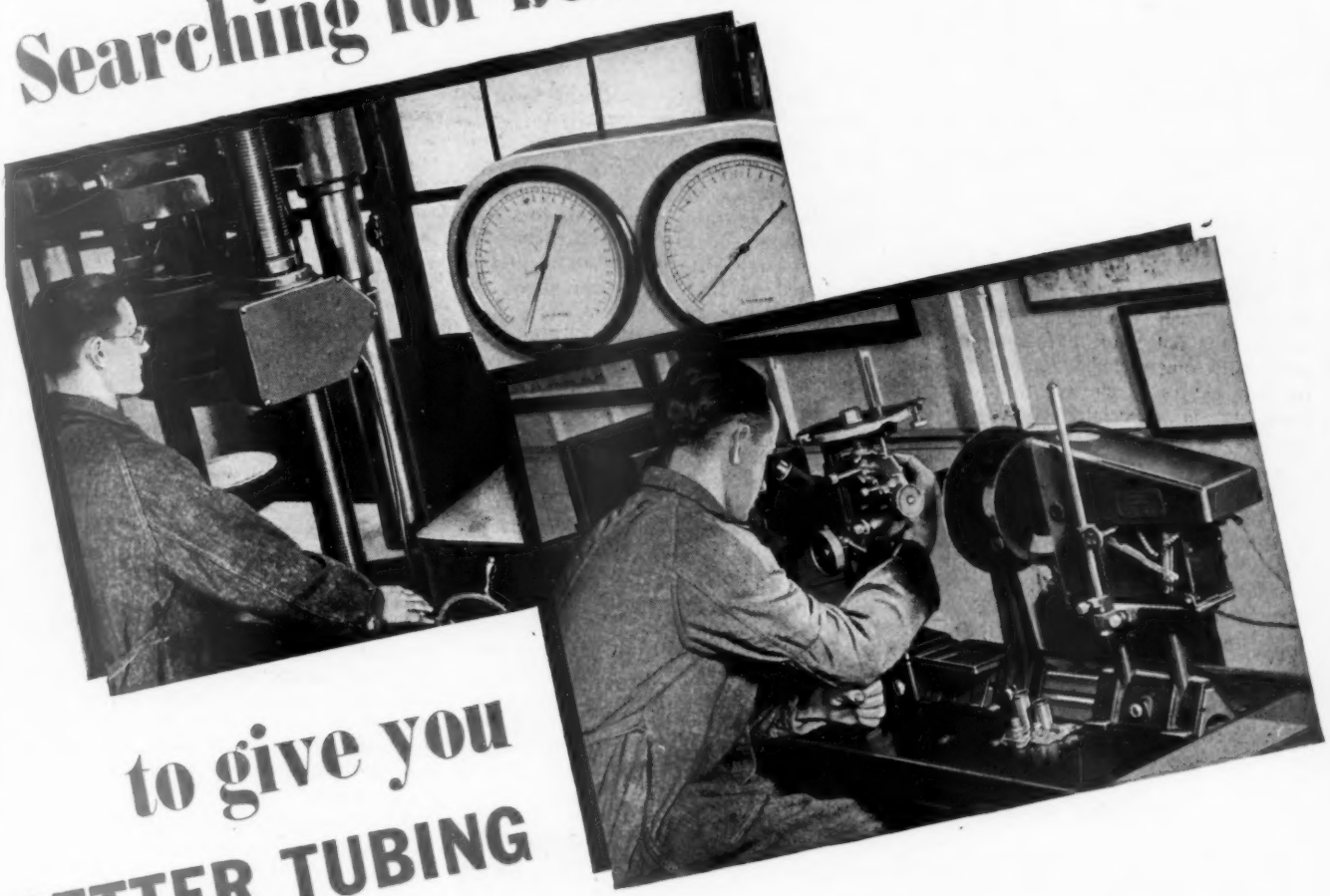

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tion as possible. In order to do this, it is generally necessary to provide insulation between the shell of the vessel and the compensating heaters, and to provide means for measuring and controlling the temperature differential between the vessel wall and the heater.

For fractionation it is general practice to employ packed towers for all except the largest pilot plants. These may or may not be designed for adiabatic operation and may differ greatly in detail, particularly as regards arrangement for providing reflux and reboiling. The importance of minimizing hold-up of material in process must be kept in mind in designing such equipment. If proper attention is not paid to this point, unnecessarily long periods of operation may be required to reach equilibrium. The foregoing is especially applicable to equipment for recycle operations.

Leakage Must Be Eliminated

It is probable that pumps and compressors are responsible for more operating difficulties than any other type of pilot plant equipment. The variable stroke plunger type pump is most widely used for pilot plant work, although variable speed pumps, both reciprocating and rotary, and centrifugals are employed to some extent. The choice of a pump for a particular application will depend on such factors as characteristics of material to be handled, pressure, temperature, and required range of capacity. It is of the utmost importance that leakage from the pump be avoided. To this end it should be provided with an adequate amount of packing and with provision for proper lubrication of the latter, if the fluid to be pumped requires it.

The selection of a compressor presents even more of a special problem than that of a pump. What has been said about leakage is of even greater importance here since a small leak may be more difficult to detect in the case of gas than liquid. Enclosed distance pieces or vented stuffing boxes connected to the suction are commonly used.

Adequate instrumentation of the pilot plant is desirable, and experience indicates that the more of the control functions that can be delegated to automatic instruments, the smoother will be the operation of the plant and the more time the operators will have to actually observe what is going on. However, it is most essential that the correct type of instrument be chosen and that it be properly adjusted for the job which it must do. Continuous records are of great value to the operators in following trends and very helpful to the supervisor in analyzing upsets or unusual occurrences.

In most cases the instruments employed are the usual industrial type, such as are used on large scale refinery units. Occasionally it may be necessary to design and build special instruments or to modify standard instruments to meet the conditions imposed.

Until quite recently liquid level controls presented a serious problem for the pilot plant engineer because most of those available required liquid hold-ups all out of proportion to the scale of operations. Now, however, instruments are available which can be installed in vessels as small in diameter as four inches.

A control valve of the proper size and characteristics is just as essential as the right instrument. Where close control is necessary, a valve positioner will frequently be of material assistance.

A Job for Specialists

With regard to fabrication and erection of pilot plant equipment, it should be pointed out that this work is a highly specialized art. Lack of adequate supervision by one who thoroughly understands the requirements and functions of the pilot plant may nullify the best efforts of the designer and add materially to operating difficulties. This is particularly true in the matter of the installation of piping, since the average mechanical group is neither experienced nor adept in handling the small sizes generally employed in pilot plant work, nor are they aware of the importance of minor leaks.

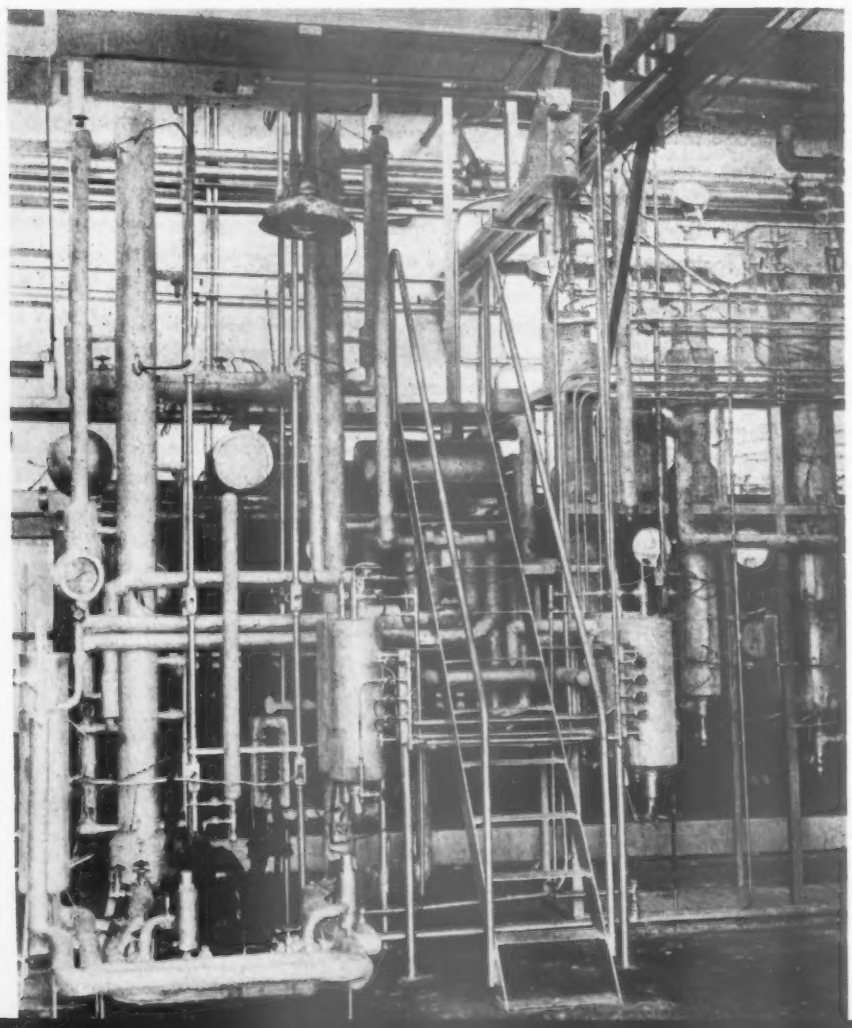
It is highly desirable (assuming qualified welding personnel are available) to use welded construction wherever possible for both the various vessels and the piping. A liberal number of unions should, however, be provided to permit dismantling various sections of the unit for cleaning or replacement. While occasionally it is permissible to install unions or flanges in lines carrying materials under high temperature-pressure conditions, it is generally preferable to use all-welded construction for such lines.

While the foregoing discussion has been devoted principally to design, it must be kept in mind that this is by no means the only factor involved in successful pilot plant work. A technical staff is needed to supervise operations and to study and correlate the results. Analysis of the various products requires the services of a well-equipped inspection laboratory.

Last but not least, properly skilled operating personnel are essential. Too much emphasis cannot be placed on training the latter group, since they are primarily responsible for the reliability of the data obtained. In this connection a good material balance is of the utmost importance and failure to obtain it should be grounds for discarding the data.

It has been truly said that successful pilot plant work depends primarily upon continuous and painstaking attention to seemingly insignificant details.

Pilot plant setup for studying a solvent extraction process



BUTANE DEHYDROGENATION*

New Process Described which is Being Used Commercially in the Manufacture of Butylene for Aviation Gasoline

*By C. C. Watson, Fred Newton, J. W. McCausland, E. H. McGrew and L. S. Kassel***

The process for the dehydrogenation of butane is a catalytic reaction in which the high operating temperatures required impose severe demands on the catalyst, which is regenerated by treatment with an oxygen-containing gas. A heat exchanger type reactor is used to provide for alternate heating the vapors and cooling during the regeneration process by hot and cold flue gas circuits. The design of the reactor involved several engineering problems, one of which was the selection of a suitable material for the tubes. A special steel alloy was adopted. An ingenious means is provided for the circulation of the cooling and heating flue gases. In commercial installations multiple pairs of reactors are used, providing for continuous operation of the process.

THE DEVELOPMENT of the butane dehydrogenation process, particularly in the pilot plant stages, has been a chemical engineering problem of sufficient interest to justify discussion at the present time. Information obtained from the pilot plants has been valuable in the design, construction, and operation of commercial plants, some of which are now in operation and others in the course of construction to meet wartime demands for aviation gasoline.

Butylenes formed from the dehydrogenation of butane are selectively polymerized to form isooctene, which is hydrogenated to isooctane, one of the principal components of aviation gasoline. The pilot plant units were designed for a combined feed ratio of 4:1, corresponding to a conversion of 25% per pass, and this conversion is being uniformly maintained throughout the life of the catalyst. Efficiencies (mols of butylenes produced per mol of butane decomposed) are of the order of 85%.

Catalyst

As pointed out by Grosse and Ipatieff[1], a successful process for the dehydrogenation of a paraffin such as butane requires the use of a catalyst, since purely thermal treatment results in a low conversion rate and an excessive yield of degradation products. The high temperatures required in order to obtain favorable equilibrium conditions impose several rather rigid demands on such a catalyst.

A satisfactory dehydrogenation contact material must first of all possess high activity in order that the desired conversion may be attained at relatively mild time-temperature conditions. This is essential if thermal decomposition is to be restricted. It is equally important, of course, for the catalyst to have high selectivity in the direction of the desired products. In addition to possessing these qualities initially, the contact material must be stable at process conditions if a reasonable life is to be obtained.

Under the conditions required for the dehydrogenation reaction, it has not been found possible to prevent a side reaction which produces a small amount of carbonaceous deposit on the catalyst. The formation of this deposit is associated with a gradual decline in catalyst activity. It is therefore necessary to regenerate the catalyst periodically by treatment with an oxygen-containing gas. During this treatment, the carbonaceous deposit is burned, with evolution of large amounts of heat. In any commercially practicable design, the temperature during the regeneration step exceeds that in processing, and thus imposes an even severer requirement on the thermal stability of the catalyst.

Catalyst Must Be Rugged

From a purely mechanical standpoint, it is of course essential that the catalyst be rugged in character in order to resist breakage under the conditions at which it is employed. This is important since any inequality in vapor flow reduces the efficiency during processing and increases local temperatures during regeneration. Initial uniformity of flow is assured by the use of pelleted catalyst and by a proper technique for loading catalyst. This initial uniformity cannot be maintained, however, unless the catalyst maintains its original form.

Other practical considerations entering into selection of a catalyst are costs and availability. The raw materials should be readily available and their cost, together with the cost of converting them into the finished catalyst, should be reasonable. Study of catalyst composition and production methods during a decade has resulted in several significant improvements[1]. The ability of the present catalyst to meet the requirements of a successful dehydrogenation process is amply demonstrated by the conversion per pass, efficiency, and life achieved in actual commercial operation. Work now in progress would indicate that a catalyst having still more attractive properties may soon be realized.

Process and Plant Requirements

Any catalyst dehydrogenation process is inherently a high-temperature operation, since the thermodynamic equilibrium conversion is low at temperatures below 950°F. The other considerations of major importance in determining the optimum operating range are, that the temperature coefficient of the catalytic reaction is less than that for thermal cracking, and that the catalytic reaction rate increases less than proportionately with the pressure.

Consider now the effect of varying the process temperature at constant conversion. If the temperature is too low, the desired conversion is thermodynamically impossible, and if it is only moderately greater than the thermodynamic minimum, a very low space velocity (large amount of catalyst) is required. The space velocity is low, not only on account of the low inherent reaction rate, but also because the reaction is strongly retarded as equilibrium is approached. Since both thermal and catalytic side reactions are largely nonequilibrium processes, they escape this retardation, and a low efficiency is obtained. On the other hand, if the temperature is too high, the rate of thermal reaction becomes comparable to that of the desired catalytic reaction, and the efficiency is again low.

Decrease of pressure is favorable since the ratio of thermal to catalytic reaction rate is decreased, the equilibrium conversion is increased, and the efficiency is correspondingly improved. However, the beneficial effect of continued pressure decrease obviously diminishes and is ultimately over-balanced by practical disadvantages. It is interesting to note that in some circumstances an increased yield of butadiene at a low pressure will be objectionable. This is especially true when dehydrogenation is operated in conjunction with alkylation. The processing temperature and pressure are largely fixed by all the above considerations.

Major factors in plant design are the high endothermic heat of reaction, the exothermic heat of regeneration, and the desirability of a moderately low pressure drop, so that the entire catalytic zone will be in the preferred low pressure range. Since the heat of reaction is about 1000 btu/lb adiabatic reaction would necessitate a temperature drop of 300°-400° at 30% conversion. Since the most practical catalytic range is only about 100°, heat of reaction must be supplied to the vapors. There are several ways in which this might have been done. The method chosen was to use a heat exchanger type reactor consisting of a large number of tubes in parallel,

*Presented before the American Institute of Chemical Engineers, Cleveland, May 16.

**All the authors are in the Research and Development Laboratories, Universal Oil Products Co., Riverside, Ill.

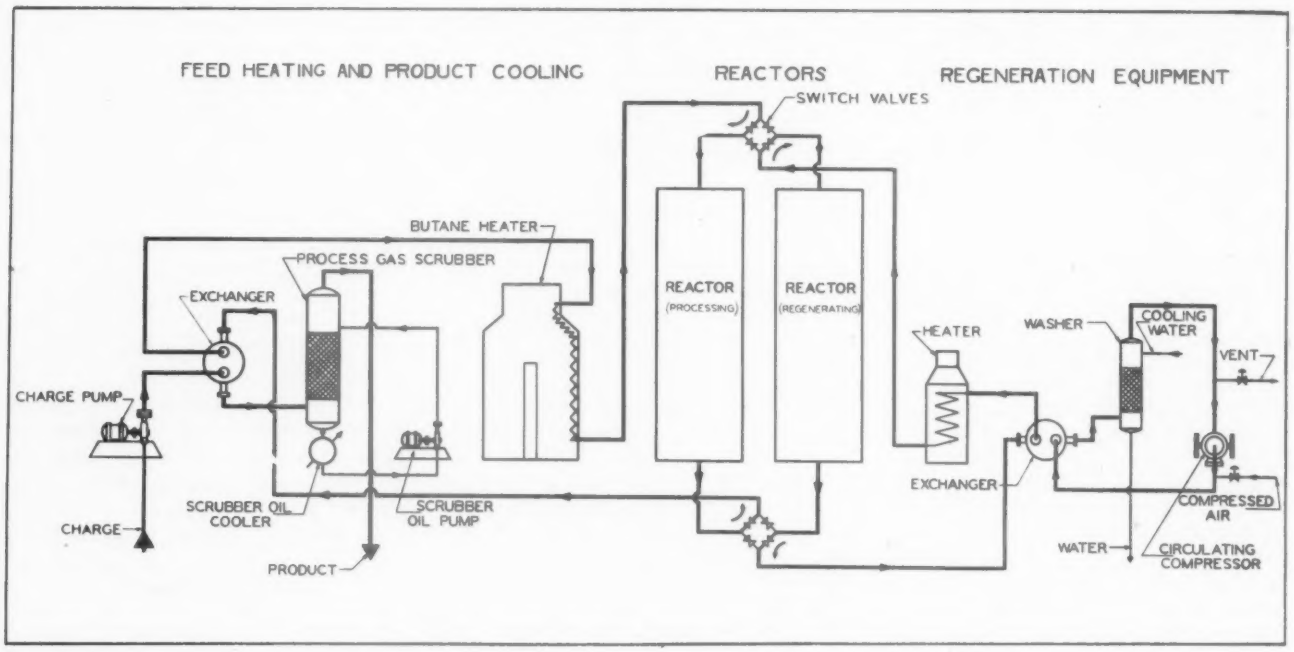


Fig. 1—Simplified flow chart for butane hydrogenation process

and to circulate hot flue gas outside of the tubes. This system is very suitable for regeneration also, cooling being provided by circulation of relatively cool flue gas. The hot and cold flue gas circuits have been partially combined as is later described in more detail.

It is a particular advantage of this type of plant that the processing and regenerating steps are mutually independent. The heat required for processing need not be supplied from regeneration, nor need the heat liberated in regeneration be absorbed in processing. Freedom from these restraints permits optimum conditions for both processing and regeneration. This advantage is obtained at the expense of thermal efficiency in comparison with a simple regenerative-type plant in which the heat of regeneration is stored in the catalyst bed at a sufficiently high temperature for use in the subsequent process period.

Detailed design studies made it seem very improbable that the simple regenerative unit would possess of sufficient stability in an operation of this character. This stability could be introduced by modifications which would divorce the heat evolution of the regeneration step from the process heat requirements. Such modifications, however, would abandon the higher thermal efficiency which was a principal advantage of the regenerative design.

How Temperature Is Controlled

The development of a molten salt, stable and noncorrosive up to at least 1250°F. which was used in the semi-commercial butadiene unit mentioned later, affords a promising alternate heat transfer fluid for use in the heat exchanger type reactor.

Regeneration must be carried out without exceeding a safe maximum temperature of about 1300°F. Temperature is controlled by cooling outside the catalyst tubes, and by recirculating regenerating gas to give a controlled oxygen content. Burning takes place in a relatively narrow zone which travels down the tube at a rate determined by the regeneration gas rate, the oxygen content, and the amount of carbon on the catalyst. Part of the heat is removed through the tube wall by the cooling flue gas, but the remainder travels through the catalyst bed at a rate determined by the regeneration gas rate and the heat capacities of the gas and the catalyst. When this rate is nearly the same as the rate of the burning wave, the two waves reinforce each other, and abnormally high peak temperatures are developed.

Tube Design Important

Control of conditions to prevent this resonance is important in the design of either heat exchanger or adiabatic type reactors; even though in the former, the heat wave is strongly damped by heat transfer through the tube walls. This control is of paramount importance in the case of an adiabatic reactor, since the heat wave cannot be thus damped. The possibility of such control in a properly designed plant of either the tubular or the adiabatic type is clearly established, not only by theoretical calculations but also by extensive pilot plant and commercial experience with dehydrogenation, catalytic cracking, and other processes. The tubular reactor design, however, because of increased flexibility in capacity, has the advantage of greater freedom in meeting changed refinery requirements.

The design of the catalyst tubes is of major importance. The total volume, of course, is that of the required amount of catalyst. The tube dimensions affect pressure drop and heat transfer rates, during both processing and regeneration. As the tube length is increased, the mass velocity inside the tube is increased, provided the space velocity is constant. Increased mass velocity gives better heat transfer between tube wall and catalyst bed and therefore permits a somewhat larger diameter. The catalyst volume per tube is therefore increased very substantially, and the number of tubes in the plant is reduced. On the other hand, the pressure drop through the tube is also markedly increased as the tubes become longer. This is unfavorable during processing because of decreased selectivity, and during regeneration because of the increased power requirement for recirculating regeneration gas. The selection of tube dimensions for the plant is based on an evaluation of these opposing effects.

The choice of a proper tube material is vital to the success of the process. The alternately oxidizing and reducing conditions to which the inner tube surface is exposed prevent formation of the stable oxide film on which many alloys depend. Even small particles of such metals as iron and nickel cause enough excessive carbon formation, to plug tubes, or even to burst them. It is therefore not satisfactory for the tube material to scale at a rate that would give several years tube life, since even this small amount of scale is intolerable because of carbon formation. The earliest laboratory work was done exclusively in quartz tubes, which are ideal chemically, but can of course receive no consideration for commercial operation.

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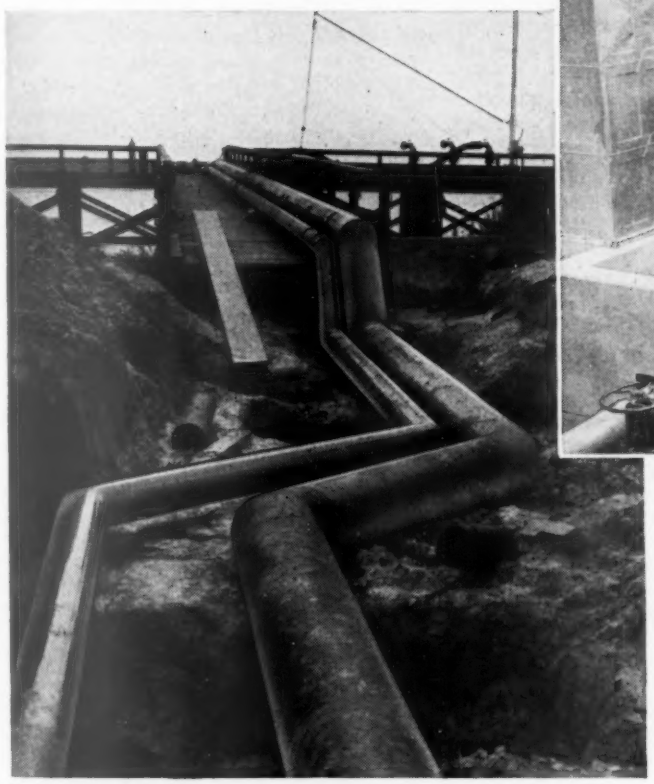

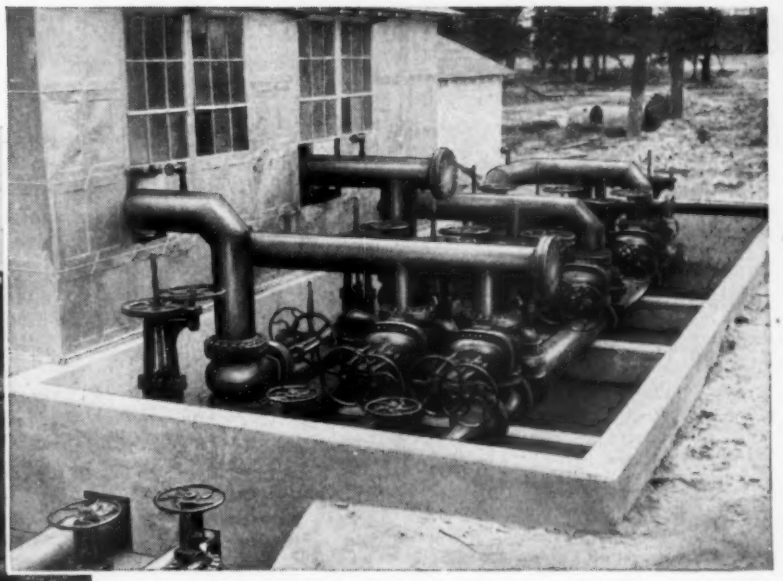

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Plant Description

A simplified flow chart for the process is shown in Fig. 1. The charge butane is pumped through a heat exchanger and heater, where it is vaporized and heated to approximately the required reaction temperature, and then is directed by means of switch valves to the processing reactor where it flows downward through all the tubes. Reaction occurs rapidly near the entrance as the charge enters the catalyst tubes; then, owing to the retarding effect of reaction products, decreases as it proceeds through the tubes.

Because the reaction is endothermic, heat is supplied by hot flue gas circulated outside the tubes. The flue gas flow is parallel to, and in the same direction as, the process gas flow inside the tubes; thus the greatest temperature difference and greatest heat flow occur at the top of the tubes, and as the flue gas is cooled, the temperature difference and heat flow become less. Since the reaction rate also decreases with flow down the tube, the reaction temperature profile will be approximately isothermal.

The butane temperatures in the inlet portion of the tube can be raised or lowered by adjusting the inlet temperatures of the flue gas and/or the butane itself. The butane temperatures in the outlet portion can be varied almost independently by adjusting the flue gas flow rate, thus changing its temperature in this zone. This flexibility permits operation at the optimum efficiency for any desired conversion.

The heating flue gas is recirculated through ducts by a fan; its temperature is raised by the addition of hot combustion products from fuel gas burned in a heater, and it is then directed by dampers to the processing reactor where its temperature is lowered by heat transferred to the reaction.

The product leaving the catalyst tubes is composed of butylene, hydrogen, unreacted butane, and small percentages of other light hydrocarbon gases resulting from side reactions. It passes through the outlet switch valves and the charge heat exchanger into a gas scrubber where it is further cooled by a circulating oil stream. The product is then sent to other processes. Usually, it is compressed and sent to an absorber for separation of the butane-butylene fraction from lighter gases. The butane-butylene fraction may be used as feed for polymerization or alkylation. In this case the unconverted butane would be separated by fractional distillation and returned to the dehydrogenation process. In other circumstances, the butane-butylene fraction might be directly resolved into butylene and recycle butane by solvent or azeotropic operations. This would be done, for example, in order to obtain concentrated butylene for charge to a butadiene plant.

3 Plants Operating

At present three commercial plants are operating the butane dehydrogenation process to supply materials for aviation gasoline components, it was brought out in this contribution from the Universal Oil Products research staff. Other plants are in the course of construction.

As previously stated, the catalyst must be regenerated after a short period of use. Operation of the switch valves, dampers, et cetera, required to place the spent reactor on regeneration and the fresh reactor on process is governed by a time cycle controller. Normally, this operation is fully automatic, but means are provided to permit remote manual operation from the control room. All operations are indicated by panel lights so that they may be followed and checked by the operator, and are interlocked to prevent any possibility of misoperation by the time cycle controller.

The regeneration operation involves passing air diluted with inert gas through the catalyst bed. Since the oxygen is removed from this mixture in the reactor, the exit regeneration gas is recycled as the diluent. Thus, the generation system consists of a closed loop through which gas is circulated by a compressor. Air is admitted to this gas before it enters the reactor and a corresponding amount of gas is vented after it leaves the reactor.

Cold Compressor Used

The regeneration system operates under pressure and uses a cold compressor. The choice of the exact pressure and the use of a cold compressor are determined by economic considerations, rather than by any requirements of the process. For example, decrease of pressure would increase the specific volume of the regeneration gas, and the frictional pressure drop. Both the size and the power requirement of the recirculating compressor would be increased. Increase of regeneration pressure, on the other hand, would lead to increased costs for air compression, and to more expensive construction.

The choice of operating pressure is based on a balance between these opposing forces. The regeneration gas is cooled before recirculation. This condenses the water vapor formed from combustion of the small hydrogen content in the carbon deposit, and thus prevents the water content from increasing to the point where it would reduce the activity of the catalyst during the following processing period. Cooling also reduces the cost of the recirculating compressor by reducing the gas volume and by eliminating the mechanical problems inherent in compressing or blowing a hot gas.

The fuel gas requirement for reheating the regeneration gas to ignition temperature is reduced by heat exchange with the gas from the reactors, and indeed, is little more than that saved by the reduction in compressor power credited to gas cooling. The result of these economies, although not apparent from the flow chart, is that the regeneration equipment is a relatively small part of the plant.

During regeneration, the reactor is cooled by circulating relatively cold flue gas outside of the tubes in the same manner as it is heated during processing by circulating hot flue gas. This cooling flue gas stream is cooled before admission to the reactor housings by injecting either a stream of cold air or a small spray of water.

Two Streams Combined

In passing through the reactor housing, the cooling flue gas is heated to about the same temperature as that to which the heating flue gas is cooled. The two streams, therefore, are combined and recirculated with a common fan. The fan discharge divides, one stream being heated and one cooled; each stream being switched by dampers to the proper reactor. This arrangement is advantageous, not only because of its simplicity, but also because it gives a substantially constant fan temperature, and permits continuous operation of the heating fire and the cooling spray or damper. Furthermore, the use of totally independent heating and cooling circuits would result in recirculation of almost pure steam or pure air in the cooling circuit, with the consequent threat of insulation damage or of duct fires. Continuous mixture of the two streams leads to a more desirable composition for the circulating medium.

One of the most obvious expedients is to use multiple pairs of reactors, each of which has its own feed flow controller, exchangers, furnace coil, switch valves, and regenerating system. Two pairs of reactors may be housed in a single structure, served by a common flue gas equipment, and have a common butane furnace structure in which the two coils are separately fired. The flow chart, Fig 1, shows one pair of reactors, with its attendant equipment. This subdivision results in individual units of optimum size. A further advantage is that switching of reactor pairs is in sequence, thus affecting only one part of the plant at a time, and hence providing a practically uniform product for charging to further processes, such as absorption. Still another advantage is that several operating reactors are always available, from which excess inert reactivation gas is drawn for purging and repressuring the switching reactor.

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JOB DESIGN—Technique for Saving Man-Hours in Routine Tasks

THE application of job design to routine tasks in oil producing operations has resulted in substantial reductions in well servicing costs and savings in man-hours for Phillips Petroleum Co., officials of the firm state. The company introduced this technique for analysis of jobs in certain field operations over four years ago.

The principles of job design are believed applicable to many repetitive tasks in refinery operations and maintenance, as well as other phases of oil company operations. There is nothing particularly new about the basic ideas of job design, however. Various systems of job analysis, time study, or work simplification have been used in many industries for some time, and are an important tool for reducing production costs.

The aim of this technique is to secure more effective utilization of labor for maintenance and unstandardized work of all kinds by:

1—Determining the essentials of the individual job.

2—Developing effective procedure for the repetitive parts of the job.

3—Determining economical size of operating and maintenance crews.

4—Training supervisors by example and securing the co-operation of workers to apply the same principles in designing the non-repetitive parts of jobs. The co-operation of workers is secured by demonstrating how they can make more effective and safer use of their efforts.

A further application of the technique of job design provides for calculating the reduction in production of a well or in the efficiency of some refinery unit or operation, for example, which results from reduced labor attention, to determine which is most profitable for the company.

How the principles of job design are applied in common routine production jobs was told by H. G. Thuesen, head of the Department of Industrial Engineering of Oklahoma Agricultural and Mechanical College, Stillwater, before a meeting of the Mid-Continent District, Division of Production, American Petroleum Institute, in Tulsa May 25. Mr. Thuesen was invited by Phillips Petroleum Co. to apply this technique for analyzing job procedure three years ago in the Burbank field in Oklahoma. It has later been installed in other fields.

Officials of this company have stated it will pay for its cost in a short time when applied to much oil company routine work, particularly maintenance operations. They believe it is a method that will be increasingly adopted by oil companies. Officials of other oil companies who heard the method described at the Tulsa meeting stated it warranted the attention of oil company management in this period of a shortage of manpower for many kinds of work.

The principal portion of the paper presented by Mr. Thuesen is published here. It is followed by a brief statement on the experience of Phillips Petroleum Co. with this technique.

The Application of Job Design To Petroleum Production Practices*

*By H. G. Thuesen***

JOB DESIGN is a phase of engineering dealing primarily with the effective utilization of labor on the job. To the best of my knowledge the first application of this technique to petroleum production was made in the fall of 1939 at the invitation of the Phillips Petroleum Co. Later the writer was assisted by M. R. Lohmann in further application with the same company.

Job Design is also termed time and motion study, motion economy and work simplification. The writer prefers the term Job Design because it seems to be the most descriptive of the several terms. While Job Design is new to petroleum production, it has been in use over a half century and is now accepted as an important tool for cost reduction in many industries.

Since labor cost is one of the largest items of cost in petroleum production, if not the largest, an increase in the efficiency of labor utilization can result in important competitive advantage. In private industry three demands must be met. These are the demands of the owners for dividends, the consumer for better products at lower prices, and the employe for higher wages for shorter hours. These demands must be met in a competitive enterprise.

Labor costs may be reduced by:
(1) Reducing the hourly wage rate,
(2) Increasing the output per man hour.

The first method is both impossible and undesirable. Thus labor cost can be reduced only by the more effective utilization of labor—labor must be saved.

This is not a new idea. Ever since the light of intelligence entered the mind of man, he has been actively engaged in devising means for saving labor. Maximum accomplishment with minimum effort is recognized to be socially desirable.

Labor is saved by:
(1) Labor saving machines.
(2) Labor saving materials (a longer lasting paint reduces labor of painting).
(3) Labor saving organization (if a group of workers are to perform a task, elevating one to plan, organize, and direct the work will save labor).
(4) Labor saving methods (the labor of doing a job is reduced by using effective job procedures).

The purpose of Job Design is to save labor through the development of effective job procedures. Job Design deals primarily with the utilization of human effort—that is, human work.

To understand Job Design it is necessary to understand the meaning of work. Though neither exists without the other, Human Work may be considered to consist of Mental and Physical Effort. In mental effort the nervous system senses, reasons, and directs; see Fig. 1. Physical effort may be expended in Doing the Job or Playing. The difference between them lies in the attitude toward them. The former is performed primarily for the reward to be gained, while the latter is done for the satisfaction to be derived from the act.

Work on the job consists of applying the contractural forces of muscles through a period of time. Muscular Actions applied through a period of Time result in Accomplishment, such as changing of a tire, which in turn may be subdivided into Elements of Accomplishment, such as removing five lug bolts. The extent of an Element of Accomplishment may be great or little as the analysis of the job on hand requires.

From the above analysis it is clear that human work is composed of two dynamic components, Motion and Time. Neither of these is sensed clearly by the human mind. Thus when it is said "The man uncoupled the pipe", only two clear mental pictures are formed. One, the pipe coupled, the other of the pipe uncoupled, with a blur of mental pictures of what happened in between. Yet it is during this hazy interval that the oppor-

*Presented before Mid-Continent District, Division of Production, American Petroleum Institute, Tulsa, May 25, 1944.

**Head, Department of Industrial Engineering, Oklahoma Agricultural and Mechanical College, Stillwater.

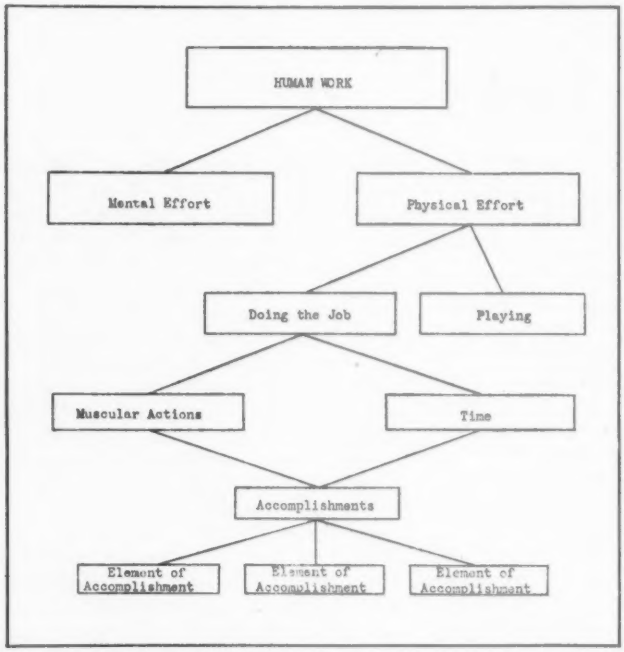


Fig. 1 (above). Concept of human work

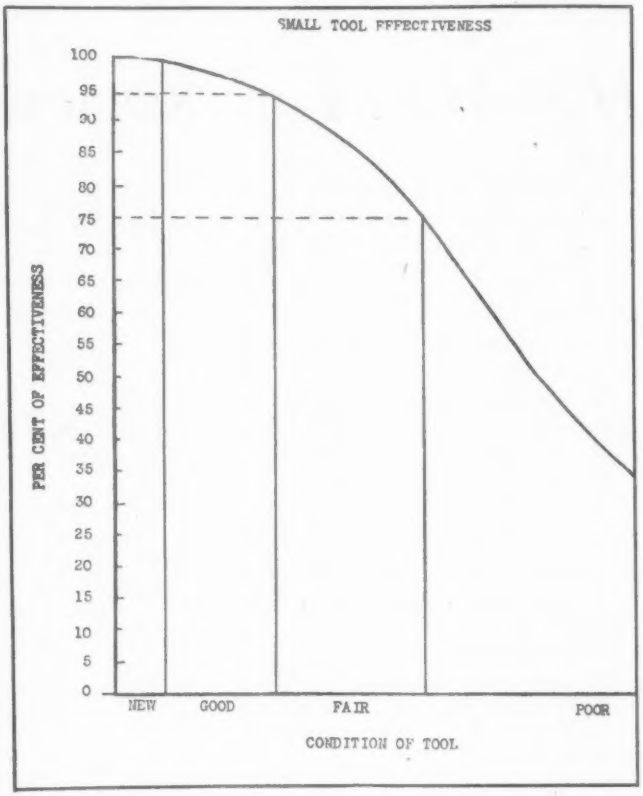


Fig. 4 (right). Schematic chart showing how production of a worker is proportional to the effectiveness of the tool he is using. Experiments have shown a dull shovel is only 77 to 93% as effective as a shovel in new or equivalent condition. For a man shoveling at $40 a week, his loss in production with a shovel 93% effective is calculated as $2.80

tunity for improving the method of doing work is improved.

What Is Job Design?

To design is to project and evaluate ideas. Job Design consists of breaking the work of the job into definable and measurable elements, analyzing these elements for effectiveness in doing work and then reconstructing the job, using only effective elements in proper sequence so that the job can be performed in the shortest time with the least effort.

Restated, Job Design consists of determining the essentials of the job and selecting effective elements of work for the accomplishment of the essentials. Methods are improved by:

(1) Eliminating unnecessary elements of work.
(2) Substituting effective for ineffective elements of work.
(3) Eliminating periods of enforced idleness.

Tools For Job Design

Since a job of even short duration is built up from a great number of elements of accomplishment, most of which are accomplished in a fraction of a minute or even a fraction of a second, tools are needed for its measurement. The machinist cannot measure accurately without his micrometer. It has long been recognized that the air pressure in a tire cannot be measured accurately without a pressure gage. In a like manner the accurate measurement of work requires specialized tools. These tools are the stop watch and the motion picture camera.

Once the measurements or data have been collected the job is represented on an Activity Chart, see Fig. 2, which is a device bearing the same relationship to Job Design as mechanical drawing bears to machine design. In representing a job on an activity chart each element of accomplishment is represented by a description of the element of accomplishment placed adjacent to a time scale in the correct relative position to indicate the time the element began and ended, thereby also indicating the lapse of time as a linear distance. With the activity chart a job is rendered static and clear to the human mind, enabling the job to be designed through the orderly and logical consideration of all factors involved.

How Jobs Are Designed

The design of a procedure for doing a job is carried on in much the same way that machines are designed.

The first step is to determine the objectives of the job in all its ramifications. Next, the job is studied to learn exactly how it is being performed. No casual observation will suffice. Accurate data must be taken on the job. Every element performed by each man and how long it took him to do it must be determined. For this purpose the stop watch and motion picture camera are used, the latter being particularly useful in getting accurate times (to .001 of a minute) of the elements performed simultaneously by several men. A job is a complex thing and a thorough study may be expected to require many hours of painstaking collection of data.

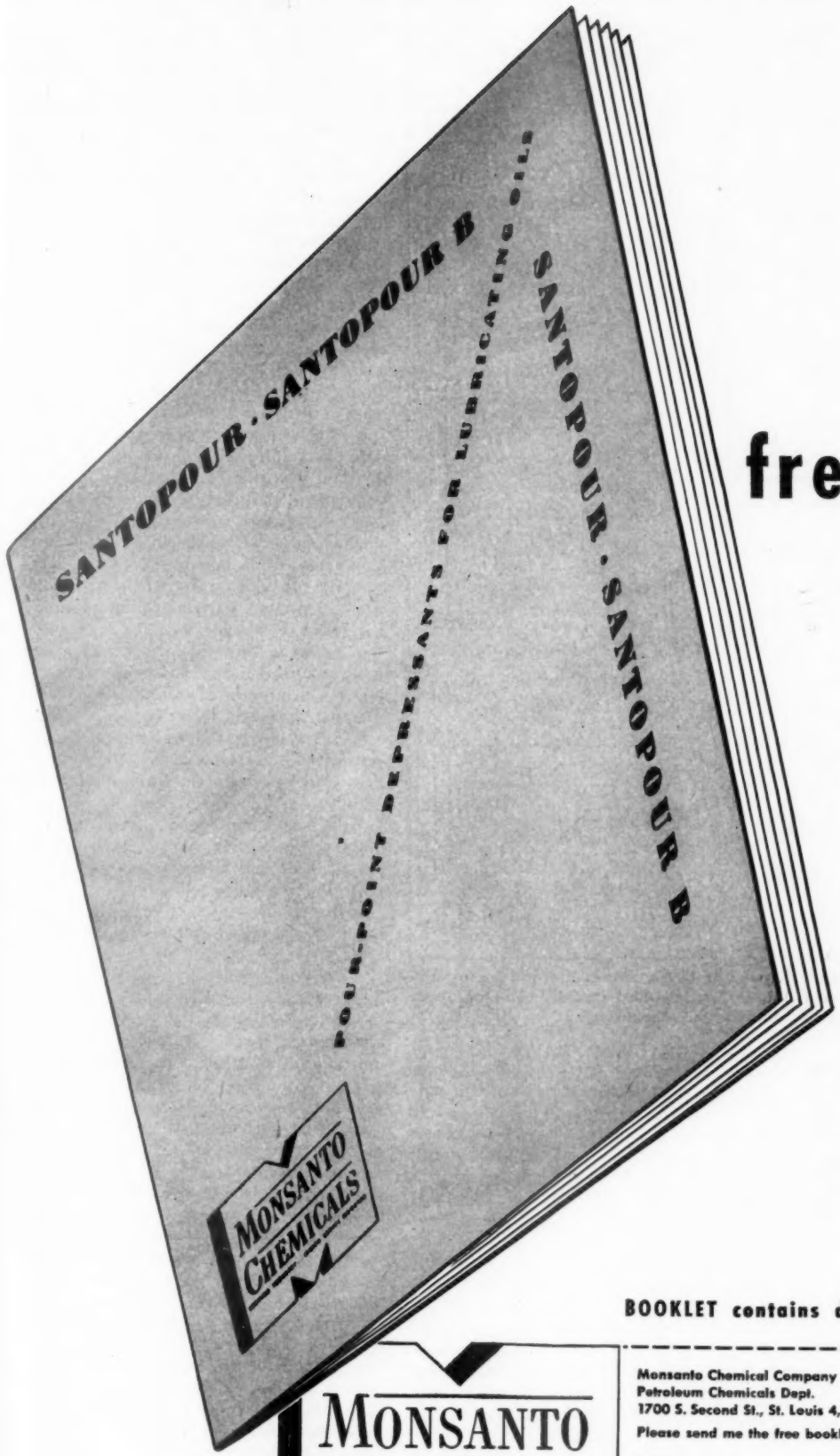
Additional time is required to analyze the data. At this point the foreman and other supervisory personnel concerned are called in for their contribution for the improvement of the job. The job precedure finally perfected is based not only on accurate factual data but also embodies the experience of those in the best position to advise on practical matters, and to put the improved methods into effect. Thus, it is clear that Job Design is essentially a means for weaving factual knowledge, the knowledge of the workman, the foreman, and higher supervision, into improved job procedures.

Putting the improved procedure into effect is entirely in the hands of the foreman and higher supervision. Therefore, as the examples to be presented are examined it should be borne in mind that the major portion of the credit for such success as was attained rests with the operating personnel under whose direction improved methods were worked out and put into effect.

Sub-Surface Maintenance

The first example to be presented is that of a four-man well-servicing crew pulling rods.

This crew was observed while it serviced several wells and accurate data was taken of all elements of the job. Data on the more difficult parts of the job was taken with the aid of a motion picture camera. From this data the activ-



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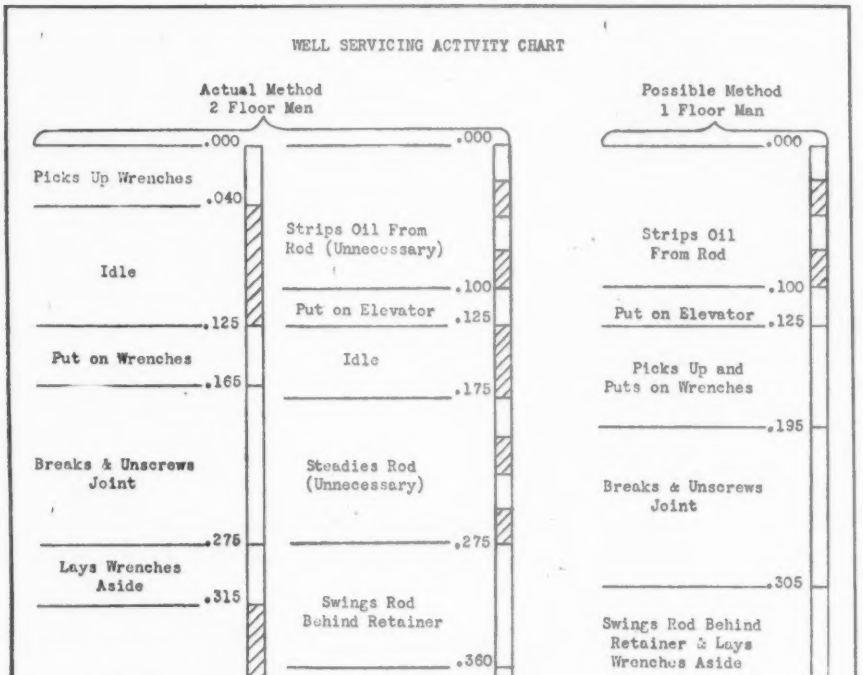

Fig. 2—Chart of elements of work and elapsed time for actual method for operation of pulling rods (left) and proposed Job Design method (right). The columns show elapsed time in thousandths of a minute

ity chart of a representative cycle, Fig. 2, showing how the two floor men performed their work in pulling rods was constructed. The vertical staffs represent elapsed time and the figures represent time in minutes. This activity chart is a static picture of the dynamic work. The chart was next analyzed and the work redesigned for greater effectiveness by:

(1) Eliminating unnecessary elements of work.
(2) Substituting effective for ineffective elements of work.
(3) Eliminating periods of enforced idleness.

In the chart of the actual method in Fig. 2, the elements of work are described and elapsed time is shown in thousandths of a minute. During the cycle the enforced idleness and semi-idleness total the equivalent (40%+36% +20%) or 96% of one man's time. Theoretically, therefore, the job is overmanned to the extent of approximately one man.

The problem is to design the job so that one floor man can perform the job. In this, it is necessary to bear in mind that the time for certain parts are fixed by winch speeds as controlled by the winch operator and the activity of the man in the top of the derrick. The job as designed appears in Fig. 2 under Possible Method.

During the first .275 minutes of the Actual Method, one or the other of the men is idle. By delaying "Pick-Up Wrenches" and later combining it with "Put on Wrenches", with a slight reduction in time and the elimination of unnecessary "Steadies Rod", one man can accomplish in .305 minutes what formerly two men accomplished in .275 minutes. "Breaks and Unscrews Joint" is done without change. Next, "Lays Wrenches Aside" and "Swings Rod Behind Retainer" is combined. "Raised Bail" is done as before. "Watches for Hook" need only be done by the man who grasps it. The combination of "Hooks onto Next Rod" and "Removes Elevator from Hook" completes the design of the new method.

At an increase of .030 minutes or 6% in cycle time, a reduction of one man from the crew has been effected. Since this cycle is repeated for only about an hour to an hour and a half without a break under the best conditions, and this part of the job is interspersed with other work through the day, the work is not judged to be severe.

In Fig. 3 all activities of each crew member involved in pulling and running rods is summarized. It will be noted that a reduction of the crew from four to three men for "Pull Rods" and "Run Rods", also results in a saving of one man in "Drive to Well" and in "Change Pump", because there is enforced idleness of three and one man, respectively, during these parts of the cycle. "Set Up" and "Break Up" in the Possible Method was charted to require the same number of man minutes as in the Actual Method, though casual observation revealed lack of work space prevented four men from being effective. Rearranging the tools and equipment on the truck bed, and particularly in planning the order in which the heavy equipment was removed from the truck and where it was placed, resulted in these elements being accomplished with three men in the time formerly taken by four. Thus, the entire job was accomplished in approximately the same time with a three-man crew as with the former four-man crew.

In a similar manner a reduction of one crew member was effected in the job of Pull and Run Tubing, which is performed in a manner similar to Pull and Run Rods with such changes as dictated by the much greater weight of the tubing.

As a final result of these studies and better planning and scheduling of work to eliminate delays and reduce driving distance (at about $.50 per mile for the unit and crew), it was possible for supervision to reduce the number of well servicing units and crews in the Smackover, Ark. pool from six to five.

This brief description precludes the consideration of many details which were taken into account, but it is hoped that it serves to illustrate the use of the activity chart for the design of a job involving several men and machines. With the aid of this chart, improvements in running rods, pulling, and running tubing and bailing have been made. Jobs requiring the simultaneous charting of the activities of five men, have been improved with this tool and in all cases we have found that it is easily understood, appeals to and demonstrates the practicality of Job Design to supervisors, foremen, and workers, alike.

The first step in the analysis and design of any job, especially maintenance jobs, is to determine the essentials of the job. This may seem an obvious step but is one too often neglected. Design is meaningless unless the objective

is clearly in mind. The objectives must first be determined before methods are devised on how to accomplish the objective.

It is economically practical to give detailed study to only those jobs or, more important, those parts of a job which are repetitive enough that savings by design when multiplied by the number of times the job or job' part is repeated, will equal an amount in excess of the cost of detailed analysis. Therefore, one of the first steps is to determine the parts of the maintenance work that is repetitive.

An example of a part of a maintenance job that is repetitive, is going to and returning from a job. We study this transportation factor from the angles of transportation medium, distance and route, and crew size, also keeping in mind that nothing worthwhile is being accomplished while men are traveling. An exaggerated story can be used to illustrate this fact. Suppose there is a maintenance job in the field that takes sixty man-minutes to complete and that it takes ten minutes to get to the job and ten minutes to return. If we decide to send a large crew to do the job, such as sixty men, theoretically it would take them 10 x 60 or 600 man-minutes to get to the job and 60 man-minutes to do the job and 600 man-minutes to return, or a total of 1260 man-minutes which at two cents a man-minute would be $25.20. Now, if one man was sent, he would take 10 man-minutes going, 60 man-minutes doing, and 10 man-minutes coming back, or a total of 80 man-minutes or $1.80. The difference in cost of doing the same job, or $23.60 represents the cost of idle time while a crew is going to and from this job.

Another repetitive part of all maintenance jobs is the unloading and placing and reloading of tools and equipment. In many cases in oil field work, this is at least 10% of the job. The arrangement of tools in a tool kit, tool chest, or on a truck is very important, if time spent in searching for and getting tools is to be kept to a minimum. To illustrate with an example from experience, there is the case where a maintenance gang kept their many small tools in a haphazard fashion in a large tool box and their largest pieces of equipment on the bed of the truck. There was considerable confusion and delay in getting the tools, the last used were the first off the truck, and generally considerable time was lost in getting ready to work. After some study of this problem, the "catch-all" tool box was eliminated and a definite and fixed place was provided for every tool where it could be reached from the ground without climbing up on the truck. This so improved the work that three men performed the set-up and break-up in less time than formerly taken by four men. It had another value in that it was possible to quickly determine before going out to the job that all tools needed were on the truck. Just because the maintenance man or crew carries a large assortment of tools and equipment is no reason to neglect the design of his work place.

Small Tool Effectiveness

Another repetitive part in all maintenance jobs is the use of tools. The output or production of a user of a tool, whether it be wrenches, screwdrivers, or pick and shovel, is directly proportional to the effectiveness of the tool. All of us, supervisors, engineers, and workers, inadequately realize the importance of good tools in first-class condition. With labor costs of nearly two cents a minute, none but the very best tools should be used. Fig. 4, based on experimental data, is a schematic chart to illustrate and dramatize the importance of having effective tools. Workers want good tools. Excellent results have been obtained by photographing tools as found in the field and then displaying them alongside photographs of good tools. This has resulted in there being set up a definite routine procedure for the inspection and reconditioning of tools periodically. This has, to a large extent, eliminated poor tools and increased the effectiveness of the workers.

Another point of study on maintenance jobs that realized large returns is crew size. It was a common procedure to send a crew of several men to do a maintenance job. Because of the limited space, all men cannot work at the same time; they are in each other's way and interfere with each other. This condition is called "labor-bound", a term that gets a response from supervisors and workmen.

Practically every time a crew is employed on a maintenance job, some and usually all members of that crew are idle a part of the time due to lack of work space. This "labor-bound" idleness may be several minutes here, a few minutes later etc., but in total it amounts to a sizable part of the job. The highest efficiency on maintenance jobs is gained by employing the minimum number of men sufficient to do the job. Large

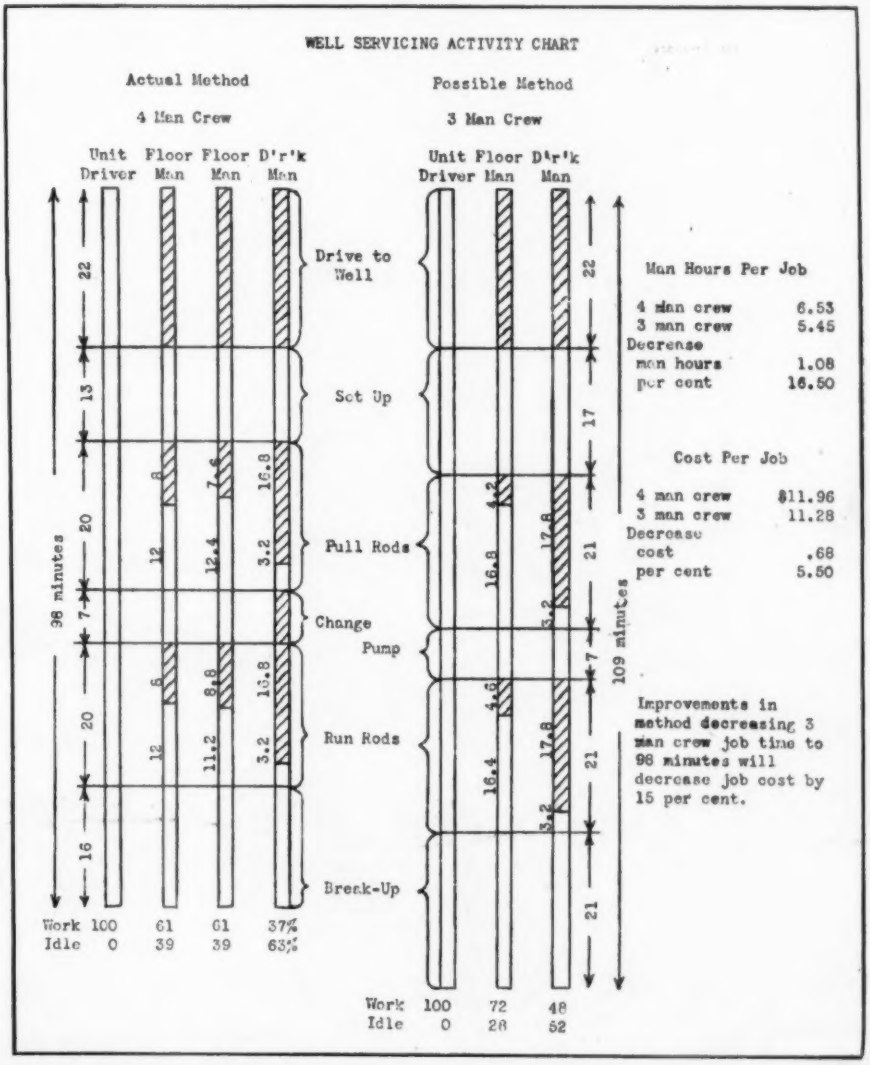

Fig. 3—Activities of individual crew members in operation of pulling and running rods. Left is actual method with four-man crew and right proposed Job Design Method with three-man crew. Columns show elapsed time in minutes

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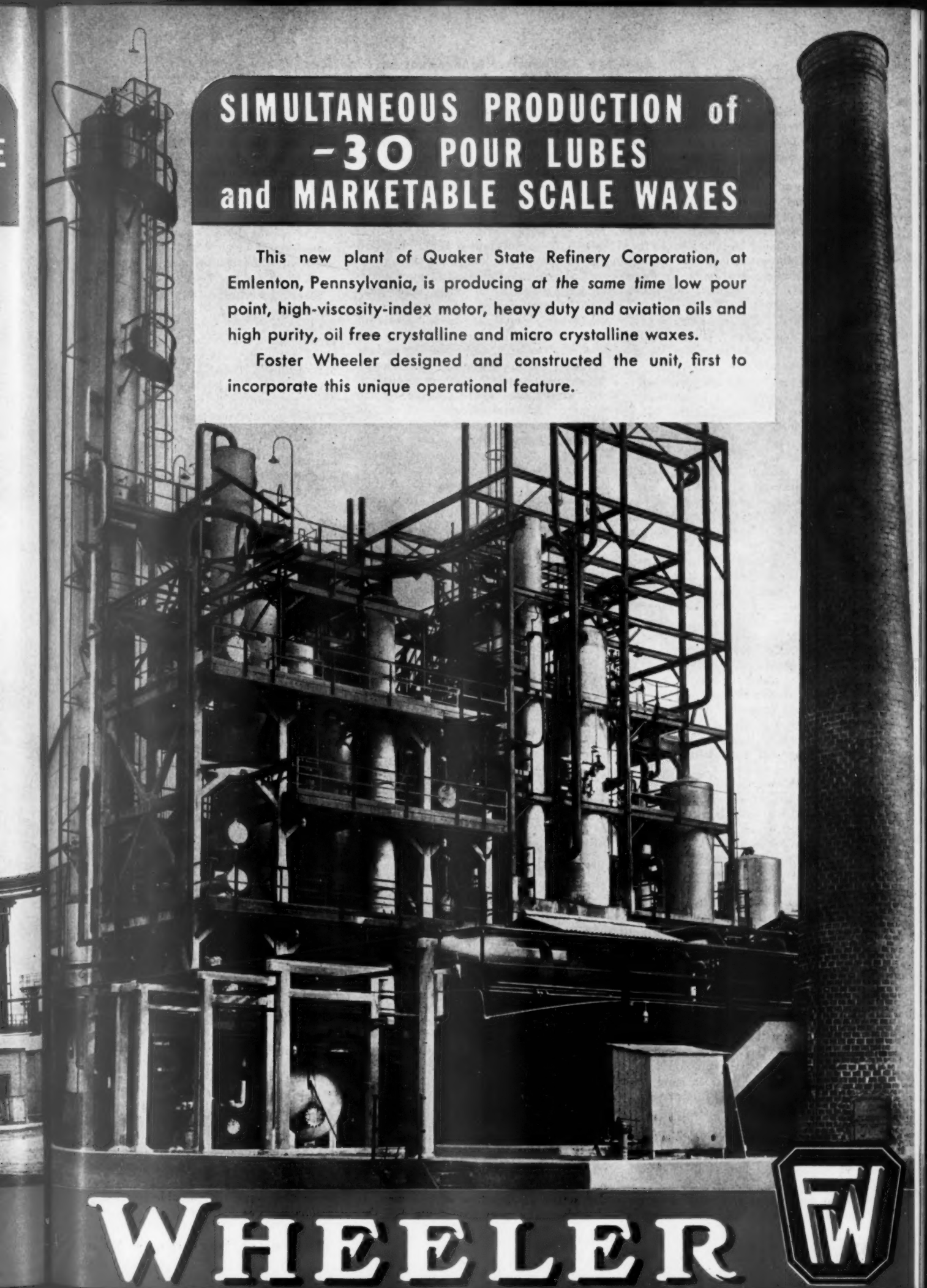
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Foster Wheeler designed and constructed the unit, first to incorporate this unique operational feature.
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crews are wastful.

A final step for improving maintenance work after designing the repetitive parts of the job and after determining economical crew size, is a short conference training program, not with the foreman on the general subject of Job Design, but on specific examples of which the foreman has intimate knowledge. In this connection, it should be remembered that the average foreman does not want a general education—he wants to know how. As has been pointed out previously, it is economically possible to analyze in detail only the repetitive parts of a maintenance job. Therefore, the foreman must analyze and improve the non-repetitive parts.

To equip him to do this, we review in detail the analysis and design of the repetitive parts, pointing out the "why" for the designed improvements. In addition, a complete study of any maintenance job that happens to be going on at the moment is made. This study will bring out improved methods that might have been used, improved tools or better methods of employing them, lost time due to lack of planning or ineffectual planning, etc.

To illustrate, a study of a maintenance job brought out the following facts: A soft rope was used to attach two cables, when an easily procurable snap connection could have been used; a maintenance truck made two trips back to the supply warehouse for common repair parts that might have been carried on the truck as a standard item of supply; a square-nosed shovel was used in digging hard earth instead of a round-nosed one; the truck was parked and materials placed in such a position as to cause extra walking and interfered with the men working on the job.

These facts, when presented to the foreman in terms of dollars and cents cost, along with a suggested improved method which would result in a substantial saving in time and cost, cause him to become motion-conscious and, more important, cost-conscious, and to make similar improvements in the work he supervises. In one instance a group leader who had been taught Job Design, made a suggestion of moving an obsolete derrick to a well which had no derrick, resulting in several hundred dollars savings per year.

The necessity for showing the foreman "how" and for motivating him to apply effective job procedures cannot be too highly stressed. To accomplish this result he needs the fullest encouragement and support of his superiors.

Briefly, the method of studying and designing maintenance and unstandardized work of all kinds, consists of four steps in this sequence:

(1) Determine the essentials of the job.
(2) Study and improve by design the repetitive parts of the job.
(3) Determine economical crew size.
(4) Train supervisors and workers by example to design the non-repetitive parts of the job.

(*An example of the application of Job Design technique to pumpers' activities in the Oklahoma City field given at this point in the paper is omitted.*)

Job Design is not a panacea to be applied indescriminately. Job Design requires specialized training, experience and aptitudes comparable to that required in any technical field. But Job Design is not an individual matter.

The realization of the full possibilities of Job Design is dependent upon thorough understanding and assistance of supervisory personnel on all levels of organization. For this reason the writer wishes to make it clear that the success of these first applications of Job Design to petroleum production, described in this paper, were made possible by the interest and understanding of C. P. Dimit, vice president in charge of production, Phillips Petroleum Co., and the helpful assistance and co-operation of his supervisory personnel, including P. J. Hubbell, J. P. Stephens, Earl Griffin, C. M. Odem, C. A. Daniels, J. N. Perkins and others.

Because Job Design deals with the utilization of labor on the job, it must be integrated into the operating policies of the organization from top to bottom if its full possibilities are to be realized. Its application requires the same managerial skill and day to day attention that is required by any fundamental operating technique.

Carefully administered, Job Design may be expected to result in relatively large savings. Based on the work that has been done, labor savings ranging from 10 to 50% may be realized in activities employing the bulk of the labor employed in petroleum production.

Experience with Job Design Described by Oil Company

NPN Staff Special

Job Design technique is definitely working out in actual practice according to officials of the Phillips Petroleum Co. First application, three years ago in Oklahoma's Burbank field, has resulted in a consistent reduction in well-servicing expense of 25% below former cost. Later applications have shown similar savings. The company does not have data available for the actual number of man-hours saved, but estimates savings of around 30% as compared with former practices.

There is no objectionable reaction from the men in the field, the company reports. "It's so honest the men can't disagree with it as soon as you show them what you are trying to do," one man put it. Explaining what is intended, that the company is trying to help the man do his work in the most efficient and safe manner, and that results of the study will not affect his pay adversely, enlists the active co-operation of the men. It also eliminates suspicion of the Job Designer as a spy or "snoop."

The designer asks the man, not his boss, what his job is and how he does it; then he stands by and watches the man at his task. In most cases, before very long the employe may say, "Now I do this this way, but I don't know why and I don't think it is necessary." Sometimes he will ask the designer why some feature cannot be eliminated and frequently he will suggest a substitution or an improvement in procedure.

After observing for a time, the designer may try his hand, soon becomes familiar with the work at hand, and usually has a number of immediate suggestions for eliminating unnecessary motions or duties. These suggestions are tried and gradually the job design takes form. After preliminary designing is complete, the new arrangements are tried out in the field, compared with the "old" way, and modified as may be necessary. The men, having had a creative hand in the scheme, accept it with active co-operation. Not infrequently they will show evidence of giving serious thought to the problem in the interim by advancing their own suggestions. Sometimes they already have put them in effect by the time the job designer's recommendations are complete and will call them to his attention.

One of the most interesting findings in the actual practice of job design, noted by Phillips officials and apparent from "production-line" studies in other industries, is that frequently the boss does not have adequate knowledge of what each individual of his crew does in performing his work. In general he understands the work and each man's job, but he never has analyzed the precise sequence of movements or jobs-within-a job from the individual worker's standpoint. One of the valuable supplementary contributions of Job Design is to provide the supervisor with this knowledge. In fact it makes him a job designer too.

It is frequently discovered that the men on the crew have been permitted or made to figure out their own procedure for doing much of the work. When he first joined the crew, the individual was given preliminary instruction, then "just put to work," and learned to perform the minute details more or less on his own. This naturally results in a toss-up whether or not he hits on the most efficient practice.

At the present time, according to Phillips company officials, Job Design has been applied in practice only to production jobs. Refinery applications may be expected in the future, however.

Those familiar with the work emphasize that Job Design is applicable to any repetitive task, from refinery pipe-fitting and maintenance, for example, to the work of the stenographer or clerk in an office. It is expected that Job Design will prove itself especially valuable in refinery maintenance work.

MODERNIZED FOR PRODUCTION OF HIGH QUALITY AVIATION BASE STOCK

New Installations and Plant Conversions Co-ordinated for Yields of Base Gasolines which will Require Minimum Amounts of Light Ends

By D. P. Thornton, Jr.
Assistant Editor NPN Technical Section

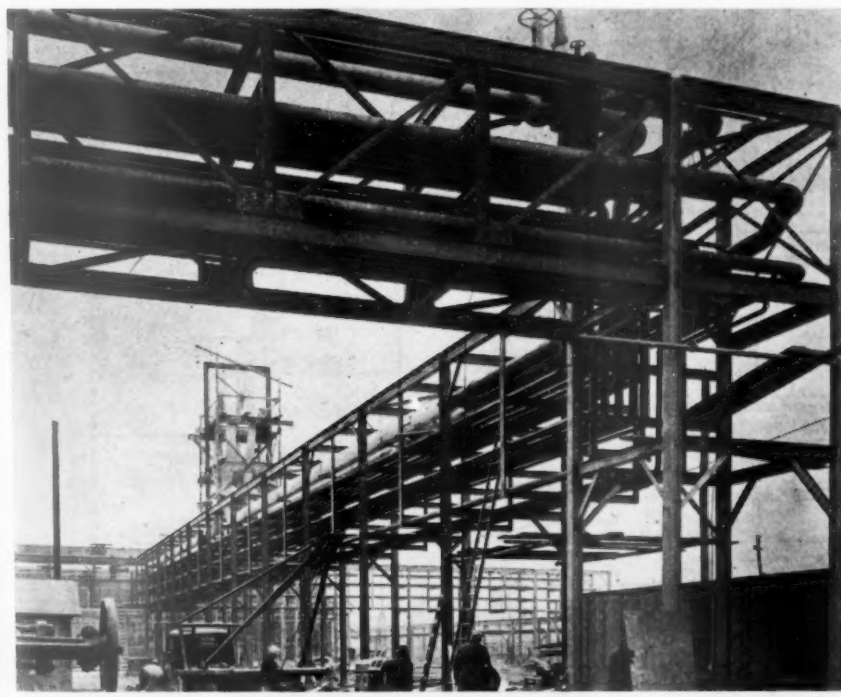
"THE most equipment and the most investment on 77 acres of any refining plant in the country." Thus succinctly does H. T. Ashton, general manager of the Lubrite Division of Socony-Vacuum Oil Co., Inc., describe the company's East St. Louis refinery, where work started late in 1942 on the installation of facilities to produce aviation gasoline for wartime needs. The plant expected to be completely on stream with all new facilities early in the summer.

The 77-acre site, by the way, includes storage capacity for 1,600,000 bbl. In 1922 when Mr. Ashton took charge of the refinery it was then a small lubricating oil manufacturing plant, occupying only a small portion of the present grounds. The site has historic significance in that development work was done there on the early Fleming cracking process and on the Pratt vapor phase process, two units of which are still in operation as thermal crackers and one as a vis-breaker. An early installation of a Knowles coke oven was also made here.

The goal of the Lubrite Division in its wartime expansion program is the largest possible production of high quality base stock for aviation gasoline, thus cutting down the amount of alkylate, hydrocodimer and cumene required for blending agents. Any deficiency locally of these products will be made up by importation from other Socony-Vacuum plants or, if necessary, by outside purchases of the desired constituent, or butane-butylene cuts from which it can be made.

In addition to new installations, extensive changes have been made in the existing equipment to tie in all units for full co-ordination in the manufacture of aviation base gasoline. When present construction is completed, the only unit which will not be in operation will be the original two-case Houdry selective polymerization plant, since its supply of isobutylene will be directed to the alkylation plant. Except for the extraordinary costs arising because of the war emergency, the new facilities and modernization of old are being financed by the Socony Vacuum company.

H. T. Ashton, general manager, Lubrite Division, Socony-Vacuum Oil Co., Inc.



Nearly all process piping is carried on racks 14 ft. above ground. As many as 30 lines, from 2 in. to 14 in., are supported in tiers which give 16-ft. clearance on all plant roads and 24 ft. on main roads

Improvements Are Listed

Here is the list of what has been done:

New Thermofor Catalytic Cracking (TCC) unit installed.

Modified hydrofluoric acid alkylation unit installed.

Major changes and additions, including a depropanizer and debutanizer, to existing gas plant and product treaters.

New water purifying plant, with capacity enough to supply domestic requirements of a city of 35,000 to 40,000 people.

New 15,000 gal. per minute forced draft cooling tower.

New Ethyl blending plant for aviation gasoline.

New laboratories, mechanical shops, storehouses and office buildings erected.

A considerable amount of new tankage constructed, and removal of many tanks from the refinery area to new storage area within the 77-acre property.

New pedestrian and pipe tunnels built under railroads from refinery to tankage areas.

Oil, steam and gas lines carried on overhead trestles.

Changes in existing Houdry installation, to permit tying in with TCC unit.

Fig. 1 shows the flow sequence of the modernized operations described in the following paragraphs.

Crude Distillation

The incoming crude stream is split into six streams to permit picking up the maximum quantity of waste heat and to reduce, by that much, the load on the crude still heater. For this purpose, two crude streams go to the condensing side of the two vapor-phase cracking stills. Two streams go to one of the two viscosity breakers (an old Pratt cracker), one crude stream to the TCC unit, and the stream with the additional required crude make-up goes to the conventionally designed heater at the crude still. All streams are commingled before entering the primary fractionator at this unit.

An interesting point here is that the salt coolant from the Houdry unit also may be cooled by preheating some of the reduced crude supply instead of using it for steam generation. This provision was installed to maintain a correct heat balance on the Houdry unit, and to utilize all the heat generated by the Houdry unit, whether or not it was needed for process and operational steam. Before the installation of the Houdry unit there was no heater for the crude topping unit, all topping heat being supplied by interchange from the thermal and vis-breaker unit. In normal operation, 75% of the crude will be heated by exchange with effluent from the various cracking units, the other 25% being heated by the crude still heater.

Inlet crude temperature to the topping still is 480-540°F., depending on operations. Bottoms temperature on the column is 450°F. (reduced crude). Straight-run gasoline goes through desulfurizing treatment and then is charged to the motor-fuel blending plant, kerosine is doctor treated before reaching storage, while naphtha is blended with distillate fuel oil from the TCC unit to form No. 3 fuel oil. Wet gas combines with that from thermal crackers and vis-breakers and is charged to the thermal unit gas plant.

All process piping except sewage, electric conduits, water lines and one crude suction line are above ground. As many as 30 lines, ranging in size from 2 in. to 14 in. I.D., are supported in up to 4 tiers on steel pillars fireproofed with concrete to a height of 14 ft. The first tier gives minimum of 16 ft. clearance on all but main plant roads, where a 24-ft. clearance is given. Expansion bends attain a maximum of 56 ft. above ground.

TCC Unit Heater

The Thermofor Catalytic Cracking unit[1], a standard 10,000 b/d (gas-oil) capacity unit, receives reduced crude from the topping unit and 650-675 e.p. gas oil from the vis-breakers. The reduced crude and gas oil are preheated with TCC tar and then go to the TCC heater and on to a tar separator where an 800-850 e.p. gas oil is flashed overhead. The tar is used as vis-breaker and vapor phase unit charge. The overhead from the tar separator is then charged to a vapor reheater which raises feed temperature sufficiently above the dew-point so there will be no vapor condensation in the TCC reactor.

The essential features of the Lummus TCC heater, aside from floor-firing, are the use of baffles for uniform heat distribution, light weight wall and arch construction, and above-grade hearth construction.

Baffle-tile construction provides a uniform evacuation of combustion gases over the entire area of the roof and increased convection heat transfer on the upper row roof tubes. The tile are supported on the upper row roof tubes and,

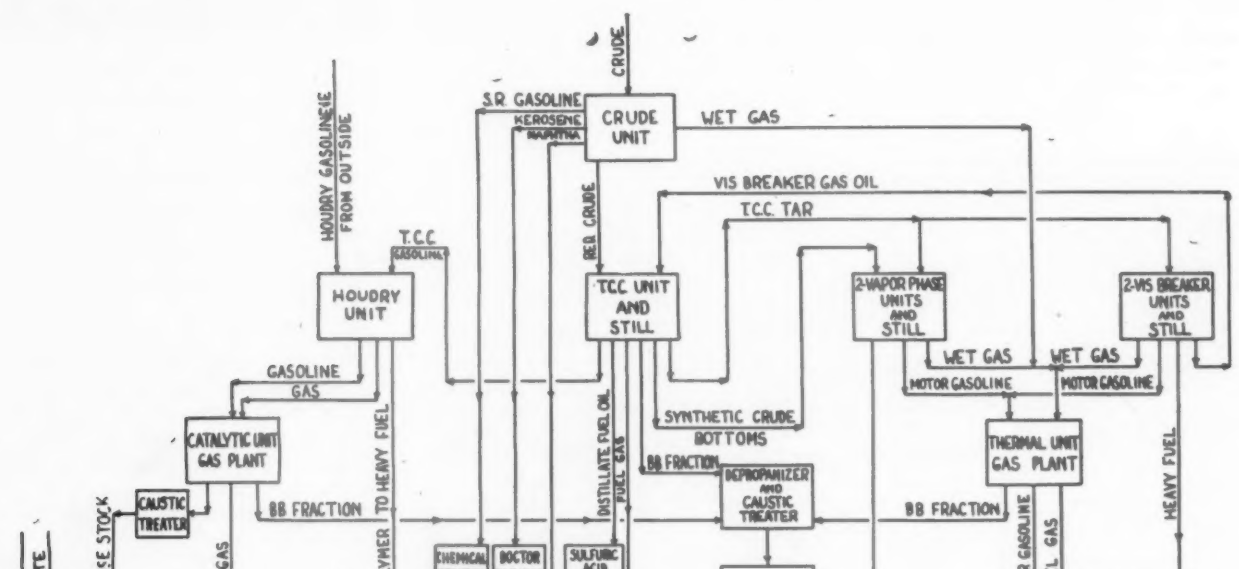
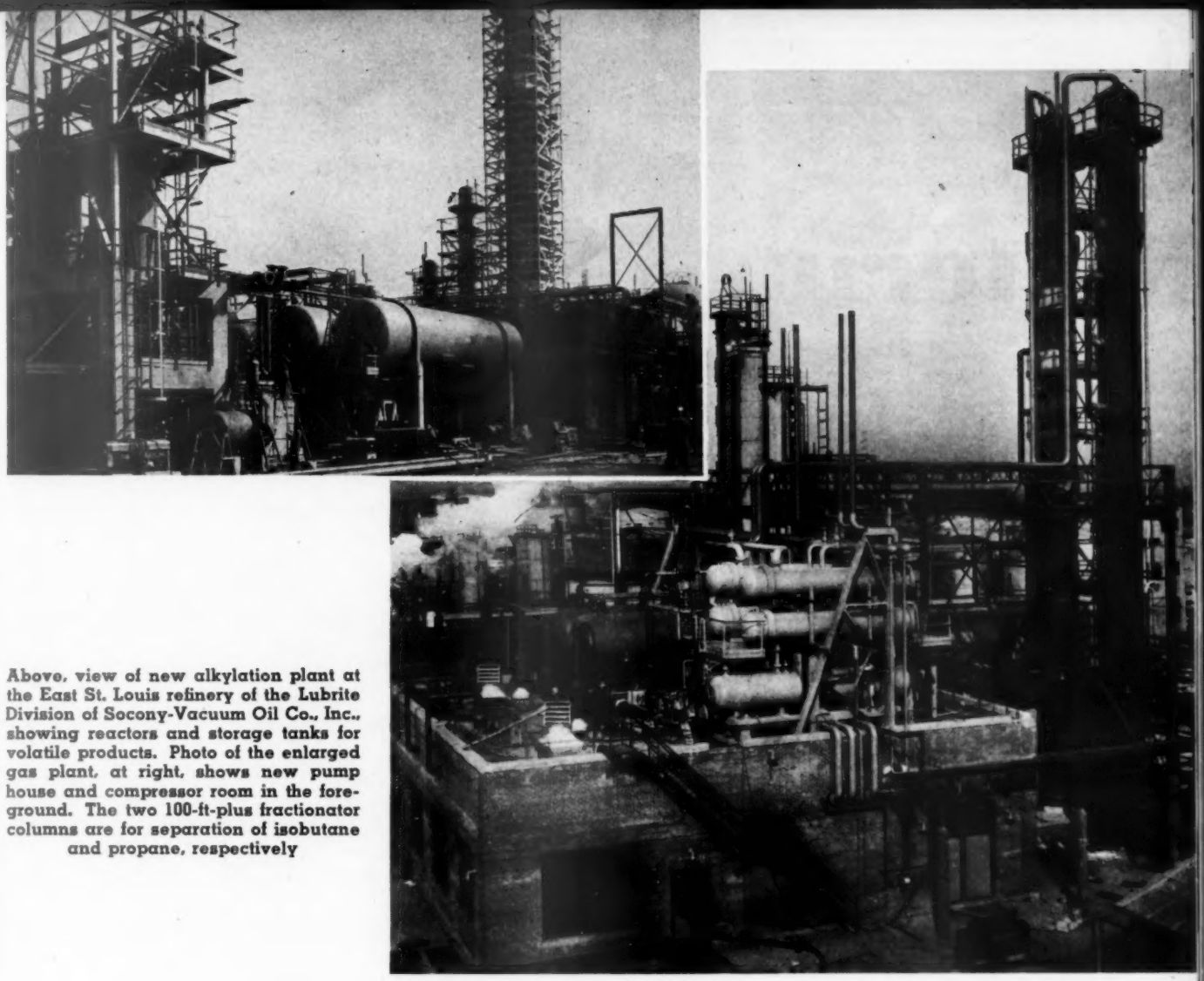


Fig. 1—Flow diagram of East St. Louis refinery, Lubrite Division, Socony-Vacuum Oil Co. Inc.



Above, view of new alkylation plant at the East St. Louis refinery of the Lubrite Division of Socony-Vacuum Oil Co., Inc., showing reactors and storage tanks for volatile products. Photo of the enlarged gas plant, at right, shows new pump house and compressor room in the foreground. The two 100-ft-plus fractionator columns are for separation of isobutane and propane, respectively

because of the uniform flow of combustion gases through the combustion zone, the side wall radiant tubes and the lower row roof tubes receive a uniform radiant heat throughout. This construction avoids the eddy currents and excessive heat transfer rates in the shock section which are caused by excessive radiant heat and high convection heat from improperly distributed combustion gas flow.

Light weight wall and arch construction has the advantage of less structural steel requirements, as well as low heat storage capacity. When the furnace is shut down it cools rapidly, reducing down-time waits.

Features of TCC Unit

The above grade hearth construction permits all the hearth refractory and insulating materials to be carried above ground by steel plate flooring and supporting steel framework. The entire furnace is encased with sheet steel eliminating air infiltration and permitting close regulation of air-fuel ratios. The heater is built for both end-fired fuel oil firing and gas-fired floor firing. Floor firing permits production of a flame bed over the entire floor area, aiding uniformity of heat transfer throughout the entire radiant section.

The TCC unit itself is of late design, including "zone cooling" in the kiln. The chief features of Socony's unit are the late model Thermofor kiln and an indicating control arrangement which permits the control room operator to identify quickly and trace the operation of valves and flow of catalyst, charge and product. Since there is a multiplicity of valves and other controls in the unit, it will be recognized that symbol or number identification alone complicates identification and selection of the proper control when the operator must move quickly, as in an emergency, or during manual control.

The Thermofor kiln is used to burn off coke deposits on the catalyst without permitting excessive temperatures (1200°F.) which might damage the catalyst. This kiln is distinguished from older designs in that water has been substituted for molten salt or steam as a coolant for temperature control. Steam generated by excess heat thus removed is available for utility or process use. As formerly, air for coke combustion enters countercurrent to catalyst.

The most unique feature about the control panel for the TCC unit, just recently developed, is the graphic temperature indicator. This is similar to the type commonly in use on Houdry units and is in part manually operated. Formerly, only clay level indicators, elevator wattmeters and valve control switches and indicating lights were supplied. Military security requirements prevent more than a general description of this panel.

The instruments indicate, in terms of tons per hour, the amount of catalyst being moved from the reactor to the kiln and the amount being taken from the kiln to the reactor hopper; level indicators tell the amount of clay above the kiln and in the reactor hopper. Signal lights give the position of valves in the vapor and clay system, and one indicates when burning temperatures within any of the zones of the kiln have reached an unsafe point. Indicators also tell whether the whole system is under manual or automatic control.

Synthetic crude from the TCC unit is conventionally fractionated into first-pass TCC gasoline, distillate fuel oil, light gases, synthetic crude bottoms, and tar. The gasoline serves as charge to the Houdry when it is operating on this charge; otherwise it is stored for later Houdry processing. It is 410 e.p. and contains some aromatics.

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Specifications and operating data on this line of instruments will be sent you on request.

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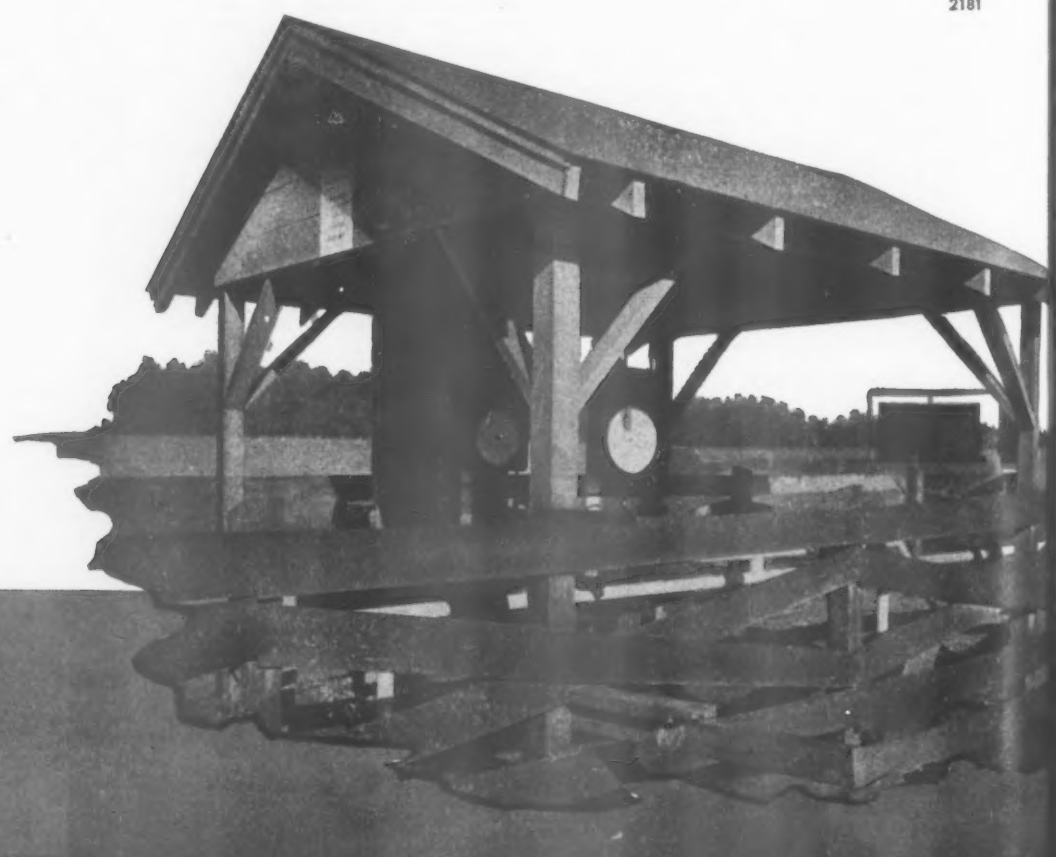

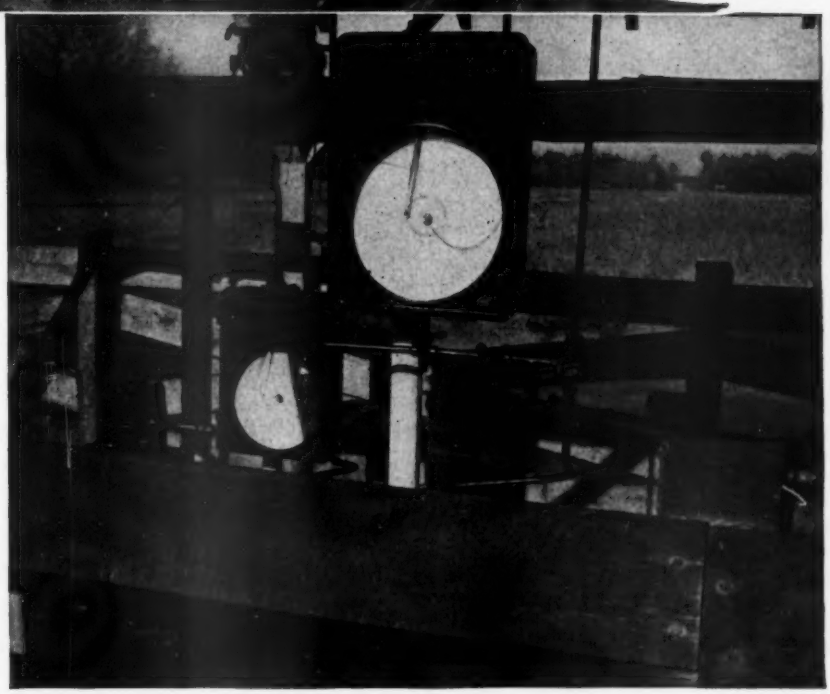

Illustrations show three views of **AMERICAN** *orifice meters measuring sour gas...McKamie Gas Cleaning Company, Magnolia, Arkansas.*

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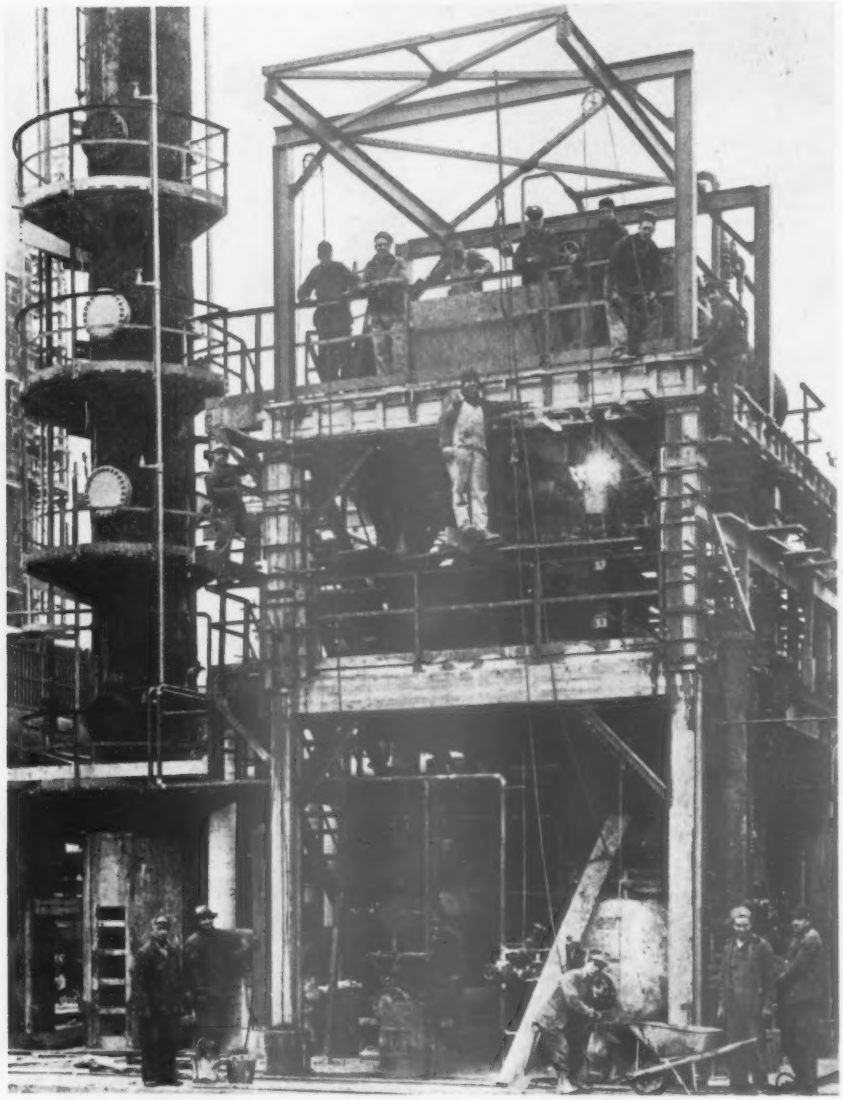

Another view of alkylation plant showing one of the fractionators, left, and the acid purification system at right

tionating facilities at the TCC unit is the partial substitution of National Radiator sections for conventional condenser capacity. The National Radiator sections, very much like ordinary cast iron radiator sections, are placed in boxes and submerged in cooling water. Thus a possible bottleneck because of scarcity in condenser supplies was averted. When and if they corrode, it will be simple and economical to replace the damaged section with an identical new one.

Thermal Cracking and Vis-Breaking

Light gases and gasoline from the TCC unit go to the gas plant, which separates gasoline for Houdry charge, "B-B" cut for the alkylation unit, and supplies propane and lighter to the refinery fuel gas system or for other processing. The synthetic crude tower bottoms stream is split, one stream forming part of the thermal cracking unit charge and some is used for recycle in the TCC.

The thermal crackers, as previously stated, are two of the original Pratt vapor phase crackers installed in the plant in 1929[2]. These stills operate in their original manner, with no quenching ahead of the evaporator. TCC synthetic crude tower bottoms, with some TCC tar, serves as the charge. Temperature at top of the evaporator (vapor) is approximately 870°F., while the liquid bottoms range from 830 to 850°F. Temperature in the reaction vessel is controlled by the reflux rate. Products from the thermal crackers are wet gas for the gas plant, motor gasoline, and heavy fuel.

One of the vis-breakers is a revamped version of the third Pratt vapor phase cracker, which was originally designed for pressure operation. The other was built in conjunction with the Knowles coke ovens. During normal operation, catalytic or thermal tar is first vis-broken before charging to the Knowles ovens, which produce a highgrade metallurgical-type coke for electrode manufacture.

The essential features of the Knowles coke oven operation[3] are a tubular preheater of conventional pipe still design to heat rapidly the charge moving through the coils at high velocity to prevent coke deposition; necessary pumps and lines; coke ovens; vapor collecting and recovery system, which includes a bubble tower, condensers and a gas separator; coke ram for removing product from the ovens; specially designed cars, a quenching station and screening facilities for grading the product.

At the present time the Knowles ovens are shut down. The vis-breaker instead functions on TCC tar, producing wet gas, motor gasoline, gas oil for TCC charge and heavy residual fuel instead of producing coke. All are separated in the bubble tower and condenser system originally used to handle coking vapors. Wet gas and motor gasoline are charged to the thermal unit gas plant.

Although considered for convenience in this article as two units, a "Thermal unit gas plant" and "catalytic unit gas plant," in actuality there is but one centrally-located gas plant. Its function as affecting operation of thermal units only will be considered in this part of the discussion. Wet gas and gasoline entering the thermal unit gas plant, from Pratt vapor-phase crackers and the vis-breakers, are first fractionated for their content of motor gasoline. Any "B-B" cut is segregated for the alkylation plant. Balance of the gases, propane and lighter, furnishes charge for the fuel gas system.

Motor gasoline stock receives treatment for sulfur removal before going to storage or blending with straight-run gasoline, heavy alkylate and normal butane from the alkylation unit, and cracked gasoline, to make conventional motor fuel.

Houdry Operation

A conventional 6-case Houdry unit has been in operation at the Lubrite refinery since early in 1940. In the aviation gasoline operation this unit charges TCC gasoline and Houdry gasoline secured from "outside" sources. Its products are naphtha, light gases, high quality gasoline and heavy polymer, the latter going direct to heavy fuel oil blending. Light gases and gasoline are charge for the "catalytic unit gas plant," where "B-B" is separated for alkylation and aviation base stock is sent through a light caustic wash to the 100-octane gasoline blending plant; propane and lighter go to the fuel gas system.

HF Alkylation Plant

An alkylation plant licensed under U.O.P. patents, using anhydrous hydrogen fluoride as catalyst and "B-B" cut for feed, was engineered by the Fluor Corp., Ltd. It is designed for the utmost simplicity commensurate with efficient and safe operation. Equipment, including pumps and valves, coming in contact with the catalyst has been reduced to the smallest number possible

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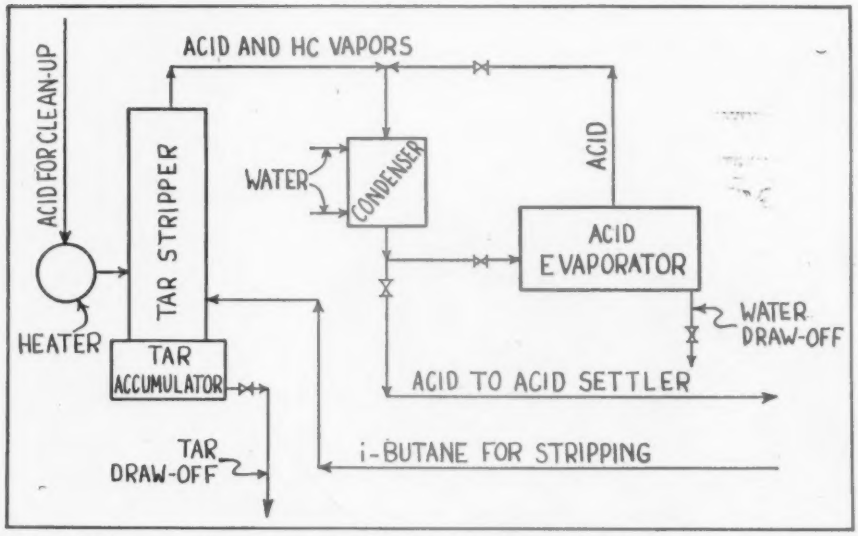


Fig. 2—Diagram of arrangement for tar stripping and dehydration for cleanup of acid from the HF alkylation plant

with sound practice. Make up acid pumps, for example, which pose a serious leakage problem around the packing, were done away with by using gas pressure for liquid transfer. Steel gate valves have been used wherever possible to relieve the supply bottleneck on "hyperseal" valves. Hyperseals have been installed where positive shut-off is required. The seal oil system has stand-by facilities ready for immediate use, to protect against leakage of hydrogen fluoride, if the regular system should fail.

In connection with handling and purification of "B-B" cuts from the various units, no new problem has been presented to the plant engineers. Long before present installations were contemplated the old Houdry two-case selective polymerization unit was fed with a treated 100% B-B fraction. This "Poly" plant is about the only old installation not used in present operation.

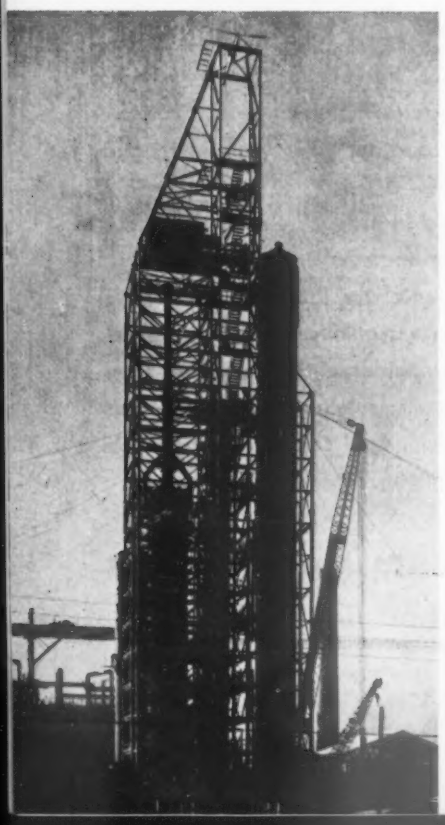
One major departure from the usual arrangement of HF alkylation plants is, however, that the dual bauxite defluorinators are located *after* the deisobutanizer.

This arrangement was made to avoid defluorinating isobutane which does not leave the system. This requires the deisobutanizer to be all steel construction, including bubble caps, trays, risers, and downcomers, as well as piping. Any hydrogen fluoride getting through the acid settler thus is automatically returned to the system as part of the recycle.

Batch operation of acid clean-up facilities (dehydration) is contemplated, although the final decision as to this must await continued on-stream operation. Tar stripping, however, will be continuous.

A diagram of the arrangement for tar-stripping and dehydration is shown in Fig. 2. A side-stream off the acid charge to alkylation contactors (approximately 5% of flow) is continuously withdrawn to a preheater, where the temperature is elevated sufficiently to vaporize the acid and any C_4 hydrocarbons, then charged to a flash tower with a receiving pot on the bottom. There are no trays or reflux in this tower, although it contains baffles to distribute flow. Acid and hydrocarbon vapors are taken overhead, together with any superheated isobutane injected to help strip acid, and condensed, while tar collects in the pot below and is withdrawn intermittently. Acid and hydrocarbons return to the acid settler, while tar is mixed with sufficient light burning oil to permit its being burned in plant furnaces.

New TCC unit, 235 ft. high, during construction. Behind it, left, is the Houdry unit



Provision is made to divert condensed overhead from the tar stripper into a horizontal drum filled nearly liquid-full of the condensate. This is heated by steam coils to flash acid vapor and hydrocarbons overhead, while water collects in the bottom. When the concentration of water in the water-acid layer reaches 40%, contents of the chamber are blown out, quickly cooled and dumped in a lime pit for neutralization. Acid losses are expected to be nominal.

Charge to the alkylation plant is "B-B" cut from thermal and vis-breaking operations as well as the Houdry and TCC catalytic cracking units. It is depropanized prior to charging and the cut then treated with a 3-stage caustic wash before being dehydrated and sent to the Stratco-type contactors. Products are aviation alkylate used for Aviation gasoline blending, and heavy alkylate and normal butane, both of which are used for motor gasoline blending.

A blow-down storage sphere has been provided with sufficient capacity to hold the entire charge for the alkylation system, in event of an emergency. A washroom also has been provided where any employe coming in contact with the acid catalyst can quickly receive the necessary first-aid which must be provided immediately.

An additional safety feature in this unit is a closed water system. This prevents any acid contaminated process cooling water from entering the main plant cooling system. Heat exchange is provided so that water from the main cooling system removes the heat from alkylation process cooling water.

The last major item to be added to the plant's equipment prior to present construction was provision for continuous blending of Ethyl fluid in finished gasoline. This system is expected to become of wide application throughout the petroleum industry. It eliminates batch tankage necessary in conventional lead blending. It was developed by L. T. Doiron, chief plant chemist, in cooperation with Proportioneers, Inc., and the Ethyl Corp.

Briefly, a portion of the gasoline stream from the treating plant is diverted to the Ethyl blending plant where it picks up sufficient T.E.L. to lead the entire stream-quantity to desired octane rating. By means of venturi-type flow meters, the amount of T.E.L. picked up from the weigh-tank by the diverted gasoline stream is controlled by main stream flow. When the diverted stream returns to the main stream, it is mixed by the existing turbulent flow. The additional agitation and mixing developed by entry into the final storage tank completes the blending.

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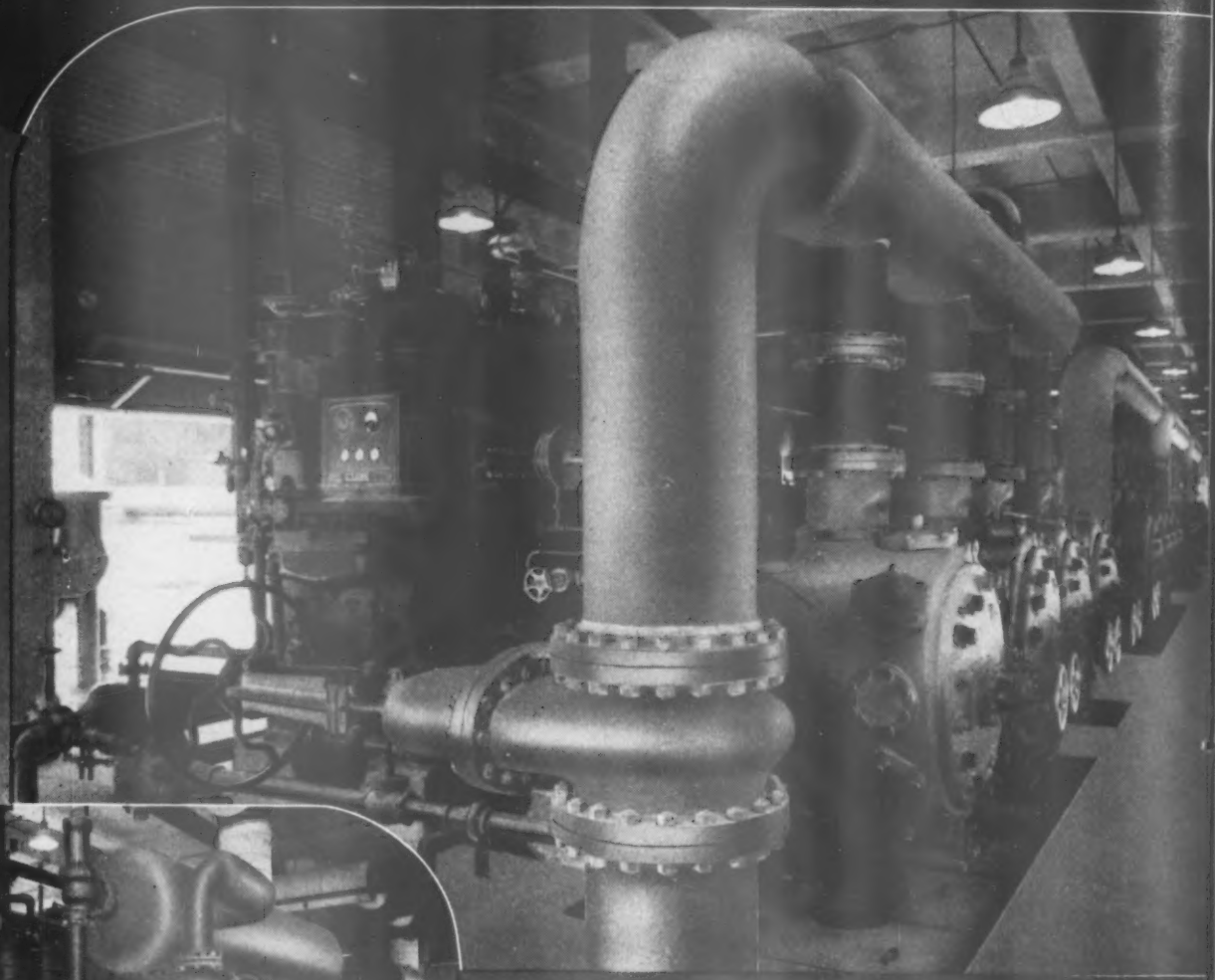
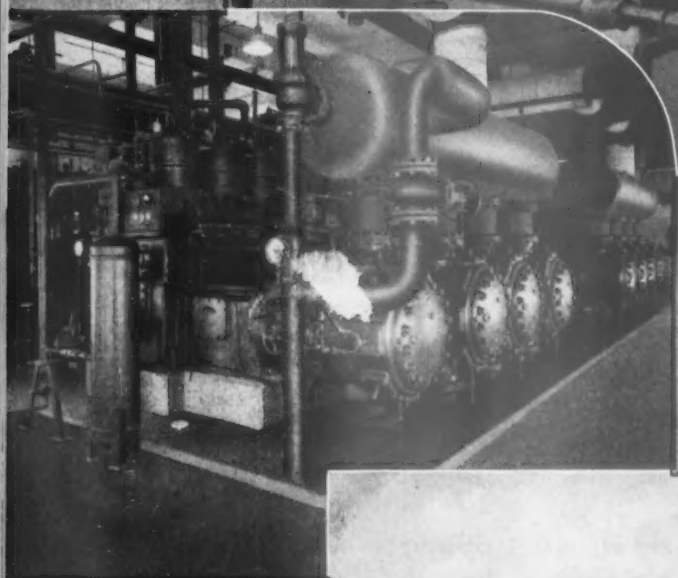


Four 600 H. P. CLARK "Angles" in "A" Cracking Plant, Cities Service Lake Charles Refinery



Four 600 HP CLARK "Angles," back to back, in "A" Alkylation Plant, Cities Service Lake Charles Refinery

Partial view Cities Service Hi-Octane Refinery. The refinery alone covers 600 acres. 25,000,000 man hours went into the construction of the two plants

This new Cities Service operated Butadiene plant will feed its product direct to a nearby Government-owned, Firestone-operated synthetic rubber plant

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The project is in reality two integrated plants . . . a 100-Octane refinery owned by Cities Service, and a Butadiene plant owned by the Government but operated by Cities Service. The latter will produce one-tenth of the nation's Butadiene. The former will produce enough Hi-Octane Gasoline to send 1,000 bombers over Germany every 24 hours.

The equipment of these plants represents the very latest improvements, discoveries and inventions in their fields. We believe it significant that 12,600 H. P. of CLARK 2-cycle "Angle" Compressors has been installed. Two of the CLARK installations are here shown . . . a 2,400 H. P. battery in the "A" Cracking Plant, and a 2,400 H. P. battery in the "A" Alkylation Plant.

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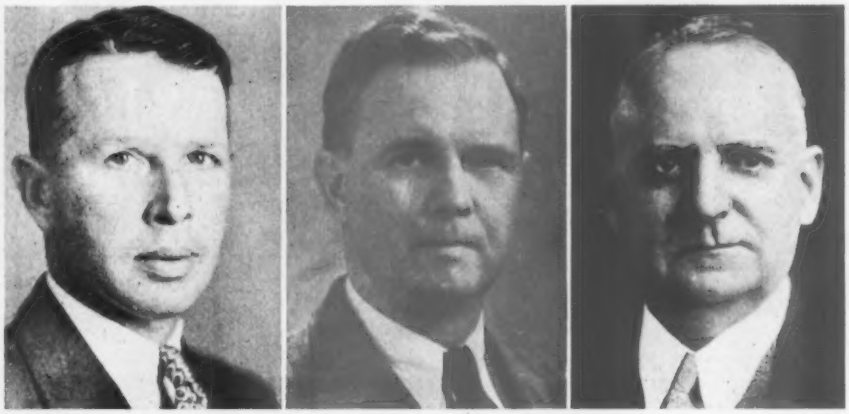

W. H. Montgomery (left), plant manager, East St. Louis refinery of Lubrite Division of Socony-Vacuum Oil Co.; D. A. Windsor (center), general superintendent, Lubrite refinery; and R. A. Frevert (right), chief engineer, Lubrite refinery

40,000 people, 2000 g.p.m., has been installed at the East St. Louis refinery. The previous system, also still operating, only handled 600 g.p.m.

Water is secured from five 90-ft. wells tapping an underground river originating in the Great Lakes area. The raw water is mixed with lime and a coagulant, then settled in basins before going to the filters. Addition of chromate completes the treatment for cooling water. Filtered water taken from the plant for boiler feed, however, is zeolite softened, then additionally treated with caustic, tannin, sodium sulfite and disodium phosphate to meet requirements.

A new cooling system, in addition to the old system capacity, had to be installed to take care of the additional requirements imposed by the TCC and alkylation units. The new tower, a 15,000 g.p.m. forced-draft type of latest Fluor design, has been built adjacent to the TCC and alkylation plants.

Building Facilities Exceptional

An interesting feature, aside from the equipment installations at the 77-acre plant, is the uniformity of appearance of the new buildings to house control rooms, laboratories, shops, offices, and other facilities. As soon as the company engineers decide on the layout and dimensions of a given building, the plans are turned over to the company's architect. He then develops the exterior design so that arch will have an attractively uniform appearance, executed in modernistic style in buff color with white trim.

In the history of the Lubrite East St. Louis refinery is interwoven the experience of the present management with some of the early petroleum refining processes. General Manager Ashton came to the old Lubrite Refining Co. in 1922 as vice president and general manager. He had formerly been general superintendent and assistant sales manager for Pure Oil Co.'s refineries at Cushing and Ardmore, Okla., with headquarters in Tulsa. The East St. Louis refinery had been built during the first war to make lubricating oil by the Wells so-called "germ" process. When the lubricating oil markets declined after the war, gasoline manufacturing capacity was added.

Not long after Mr. Ashton came with the company it was decided to install cracking facilities and the Fleming process was selected.(4) This system used a still set on end in a furnace so designed that only the vertical circumference of the still was subjected to heat. The oil to be cracked was introduced into the bottom of a column of heavier oil in the still, which was heated to above the desired reaction temperature. High pressures were used for those days. Water vapor was introduced to aid condensation of the overhead.

In 1929 the Vacuum Oil Co. bought Lubrite and Mr. Ashton became president and general manager of Lubrite Refining Corp., which later became Lubrite Division of Socony Vacuum Oil Co., Inc. Shortly thereafter development work was started at the refinery on the Pratt vapor phase cracking process under the supervision of the inventor, C. J. Pratt, and R. A. Frevert, refinery engineer. Three Pratt stills were built, which are in use today as described earlier in this article. They are said to be the only units of this type in existence today.

Pratt Process Used

The Pratt process(2) as operated in the early days, consisted essentially of a low-pressure high-temperature cracking operation in which a gas oil was heated in a tube still, discharged into an "evaporator" where the heated oil and vapors contacted a pre-heated heavy oil. The relatively low-temperature heavy oil condensed heavier fractions of the high temperature vapors, while the heavy oil was vaporized and slightly cracked by the heat absorbed from the high temperature vapors. Gases were drawn off the top of the evaporator for condensation into gasoline and other light products; the heavy evaporator residuum was drawn off as fuel oil.

The two Pratt stills have a combined gas oil capacity of 2100 b/d, although they have been operating on reduced crude, with capacity of 3500 b/d, since 1936. The stream efficiency of these units has been increased to 90%, with an overall average of 87-88% since 1929. Company officials say they are still "going strong" with a lot of the original 18-8 stainless steel tubes still in service. Flue gas temperatures over the bridge wall are reported in the neighborhood of 1450-1550°F., with temperature of effluent held at 1070°F.

Reason given by company engineers for the long life of some of the tubes is that, despite high temperatures, pressure is only 40 psi. Gasoline produced, although an excellent motor fuel of 81 (Research) octane rating, is not acceptable as an aviation fuel or even as a component.

In 1938 additional equipment was added, this time the earliest commercial design of a two-case Houdry selective polymerization unit. Because the output of the Pratt crackers always has been high in olefins, this unit operated almost 100% on butylenes. It is a liquid-phase poly unit, operating under 500 psi pressure, but will not be used in the company's 100-octane program, having been supplemented by the HF alkylation plant now under construction.

W. H. Montgomery, plant manager, was formerly assistant manager of the Standard-Vacuum Oil Co. refinery at Palembang, Sumatra, Dutch East Indies. He assisted in the planning of the demolition program by which the plant was destroyed just before the Japs came in.

D. A. Windsor, general superintendent, has been in charge of the plant for 20 years. He was brought in from Oklahoma by Mr. Ashton not long after he came to St. Louis.

R. A. Frevert is chief engineer; J. B. Hickey, operating superintendent, and D. P. Parker, assistant operating superintendent.

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Key Technologists in New Wartime Plants

Headquarters Staff and Toledo Refinery of Standard Oil (Ohio)

Standard Oil Co. (Ohio) has a big stake in 100-octane production. The aviation gasoline plant at the Toledo refinery includes alkylation, cumene and dimer units, while the No. 1 refinery in Cleveland has just put a new fixed-bed catalytic cracking unit on stream.

The technical staff which heads up all of Standard's various refineries operates from the company's main offices in Cleveland.

In charge of the process and development work behind these new aviation gasoline projects is Elliott B. McConnell, head of Standard's Refinery Process and Development section. After graduation from Cornell University in 1923, Mr. McConnell started his career in the refining industry with the Standard Oil Co. of N. J. Four years later he was sent to Cleveland to help start up two new 750 lb. cracking coils of the Standard Oil Co. (Ohio).

In 1928 he was made assistant to the vice president in charge of manufacturing, and has held that position since. For five months in 1942 he was "loaned" to the government as Special Technical Assistant to the Director of the Refining Division of the PAW.

Assisting Mr. McConnell is Edward S. Bale, Supervisor of the Technical Service Section. He was graduated from Case School of Applied Science in 1934 with a B.S. in Chemical Engineering, and then went to the Bayway refinery of the Standard Oil Co. of N. J. There he worked on plant scale cracking testing and combustion studies as a process control engineer. He switched to the Toledo refinery of Standard of Ohio in 1939 as a process engineer. For the past five years he has been in his present position, participating in plant testing design and refinery development. His work has included the aviation gasoline plants at Toledo and Cleveland.

All mechanical work has been under the supervision of Howard F. West, who handled material priorities and development of engineering on utility facilities for the new units. Immediately following graduation from Ohio State University, Mr. West joined the Standard Oil Development Co. and took their engineers' training course. Shortly thereafter he was transferred to the general engineering department in the safety inspection division. He remained in this department, traveling about the country inspecting high pressure cracking equipment operated directly or indirectly by Standard of N. J. until 1934. Then he came to Standard of Ohio to organize a safety inspection department, remaining in that work until 1937, when he was promoted to the staff of the vice president in charge of manufacturing as chief mechanical engineer of the department.

During the last several years he has been actively engaged in directing the company's 100-octane construction program.

Assisting Mr. West is Richard S. Stewart, another graduate of Cornell. He came to Standard of Ohio in 1938, after six years with The Texas Co. at various refineries in Texas, to serve on the vice president's staff. His time was devoted to engineering, maintenance and construction work until a year ago, when he was appointed assistant to handle industrial relations work for the manufacturing department.

H. F. West

R. S. Stewart

E. B. McConnell

* * *

F. J. Sanders, superintendent of the Toledo refinery, received a B.S. degree in mechanical engineering from Texas Technological College and a Ph. D. degree in chemical engineering from Yale University. He worked at various times as a junior engineer in the Technical Service Division of the Standard Oil Co. of New Jersey as a control chemist, for the Naugatuck Chemical Co. and as a student engineer for the Calco Chemical Co. He commenced work for Standard of Ohio in their Technical Service Division in 1934 and in 1939 was transferred to the Toledo refinery.

Sketches of C. H. Metz, Jr., superintendent at Standard's No. 1 refinery in Cleveland, and of his staff will be presented in a later issue of NPN's Technical Section.

Wallace K. Bergen, assistant superintendent of the Toledo refinery, began working in the engineering department of Standard's Lima, Ohio refinery, where he later became cracking foreman. Later he served as cracking foreman and general process foreman at Sohio's Latonia, Kentucky, refinery and in 1940 was transferred to the Toledo refinery in his present capacity. Mr. Bergen received his early education in Colorado and Wyoming, was graduated from the University

of Cincinnati with the degrees of chemical engineer and master of science, and was commissioned in the Officers Reserve Corps of the U. S. Army at Aberdeen Proving Grounds.

* * *

Herbert H. Chapman, head of the cracking division of Toledo refinery, entered the employ of the Standard Oil Co. in Neodesha, Kans., in 1915 as swingman fireman on a battery of Burton pressure stills. Advancing to Burton still foreman, he was transferred to Standard Oil of Ohio in 1921 when the new refinery in Toledo was placed in operation. He continued as foreman at this plant until 1932 when he was placed in charge of operations of the tube and tank unit and D & S plant. In 1937 when the present Kellogg thermal cracking and crude topping unit, poly plant, debutanizing and depropanizing plants replaced the tube and tank unit, he was moved to direct their operations. In 1941 the present alkylation plant and delayed coking units were built and placed under his supervision. During 1942 the poly plant was revamped into a cumene plant.

* * *

J. L. Collins, process engineer at Toledo refinery, has assisted mainly in the company's aviation gasoline program. He graduated from Ohio State University with a degree in chemical engineering and began working for the company as chemist in the No. 2 works laboratory in Cleveland. Three years later when the technical service department was founded, he was transferred to this new department where he worked first under Dr. Sanders and later under E. S. Bale.

In 1941 he was sent to the Toledo refinery as process engineer.

F. J. Sanders

W. K. Bergen

H. H. Chapman

J. L. Collins

K. N. Thompson

Kevin Norton Thompson, assistant process foreman in the Toledo refinery, devotes all his time to operating supervision of the alkylation, cumene, and dimer plants. He gained experience as a junior draftsman before going to Case School of Applied Science where he obtained his degree in electrical engineering. After several years in the steel industry, Mr. Thompson came to Standard's Toledo refinery in 1937 as instrument man and set up a separate instrument department a year later. He supervised instrument installation and maintenance on several new units until 1941 when he was transferred to process work in his present position.

He is now devoting all of his time to supervising operation of Toledo's alkylation, cumene and dimer plants.

Continental Oil Co. Aviation 'Gas' Plant

THE aviation gasoline plant of Continental Oil Co. at Lake Charles, La., was put into operation on June 1, 1941, under the supervision of J. E. Fenex, refinery superintendent, William Cocke, assistant superintendent, and Horace Luntz, plant technologist. When both Cocke and Luntz entered the Army in the early part of 1942, they were replaced by H. R. Wall, present assistant superintendent, and K. S. Andrea, plant technologist.

Mr. Fenex joined Continental Oil Co. in January, 1922, at its Glenrock, Wyo., refinery and worked in all departments of that refinery until 1927, when he went to the company's Wichita Falls, Texas, refinery as an operating foreman. He served next as assistant superintendent at the company's plants at Sapulpa, Okla., and Wichita Falls, and became the first superintendent of the Denver refinery. He held this post for 10 years until his move to the Lake Charles refinery in 1940.

Mr. Wall, after graduating from the University of Colorado in 1934, was employed by Continental Oil Co. at its Denver refinery in 1935. After two and one-half years he was transferred to the Ponca City, Okla., refinery, serving in the capacity of cracking plant inspector and technologist. He assumed his duties as assistant superintendent of the Lake Charles refinery in August, 1942.

Mr. Andrea's first employment, after graduating from the University of Colorado in 1937 with a degree in chemical engineering, was with the Derby Oil Co. at Wichita, Kan. He joined Continental in April, 1941, as analytical chemist at Ponca City and six months later was transferred to the Lake Charles refinery as technologist.

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R-536

Laboratory Method for Determining The Activity of Cracking Catalysts

Standard Test Devised for Arriving at Yield of Motor Gasoline Under Conditions Simulating Commercial Operation

By J. Alexander and H. G. Shimp**

An accurate reproducible test for determining the type of catalyst with the most suitable properties for the commercial cracking operation contemplated was developed to control the manufacture of the catalyst. The test method has been found to give accurate catalyst evaluations and has been adopted by one large refiner. It is believed this method, described here, will serve equally as a tool for control of the catalyst in other types of cracking units.

THE cracking catalysts employed for a number of years in the Houdry fixed-bed process and more recently in the Thermofor Catalytic Cracking process are the results of several years of experimentation. It has been found beneficial to supply each commercial unit with a catalyst possessing the best activity for the operation to be conducted.

As an example, optimum conditions for cracking heavy gas oil in a fixed-bed unit usually require a catalyst with an activity index** in the range of 30 or 35, whereas, when cracking lighter stocks catalyst with greater activity is to be preferred. Similar general conditions pertain to TCC moving-bed units and for treating operations. In order to control the manufacture of these catalysts and properly to correlate catalyst requirements as determined by the laboratory with the commercial manufacture, and to follow the actual operation of commercial units, it was found desirable to utilize an accurate reproducible test for catalyst activity.

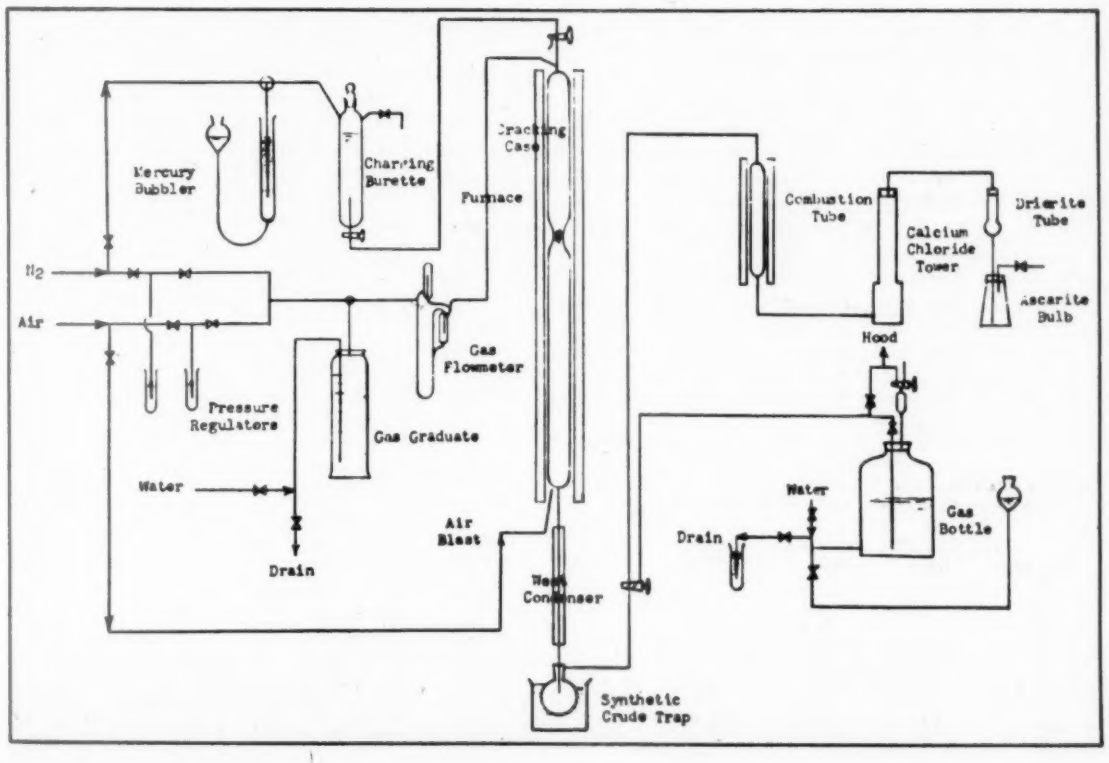
Such a method has been developed by the research laboratory of the Catalytic Development Corp., and is now accepted as a standard by this company, the Houdry Process Corp. and the Socony-Vacuum Oil Co. Its past success has been largely due to the fact that the operating conditions were chosen to simulate those in a commercial unit of the types above mentioned. However, we now feel that it will prove an equally useful tool in controlling activities in other types of cracking units where operating conditions may be quite different.

A description of the apparatus and of the operating procedure is presented in the remainder of this article.

The apparatus now in use is the result of many years of experience. Its prototype was originally built in 1938 and the present design has been in daily use since January, 1942. This apparatus is constructed almost entirely of glass and is designed to hold 200 cc of catalyst. The operating conditions and the charging stock are maintained as constant as possible; and the data—vol.% gasoline (410°F. E.p.), Wt. % wet gas, Sp.Gr. of wet gas, Wt. % catalyst deposit—are carefully measured in order to afford an accurate comparison between catalysts.

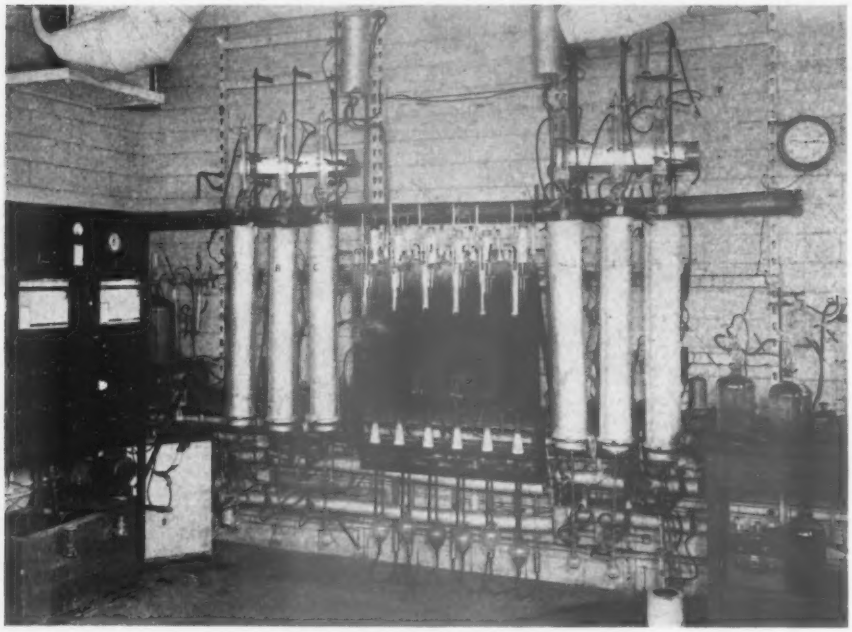
The degree of accuracy and reproducibility of the test over prolonged periods of time and among different laboratories, is considerably better than that necessary for the commercial application of the data obtained. The apparatus can be run by non-technical laboratory assistants after several weeks' training and is comparatively free from operating dif-

Fig. 1 (left)—Flow diagram of laboratory apparatus for determining cracking catalyst activity. Photo at right shows reaction chamber, made of two sections of pyrex tubing



*Houdry Process Corp., Marcus Hook, Pa.

**Volume per cent motor gasoline obtained by the standard laboratory test.



Bank of laboratory apparatus used for determining cracking catalyst activity

ficulties. A flow diagram of the apparatus is shown in Fig. 1.

The reaction chamber is made up of two connected sections of 25 mm pyrex tubing, each fitted with a thermocouple well. The upper section is used as a vaporizer, and is filled with a high heat capacity material such as crushed quartz. The lower section, with a capacity of 200-220 cc, contains the catalyst to be tested.

The furnace surrounding the reaction chamber consists of two sections of pipe preferably separated by a thin layer of insulation. The lower section, around the catalyst bed, is made of 3 in. O.D. aluminum bar, and the upper section, surrounding the preheater, of 1¼ in. iron pipe. Both sections are heated electrically and must be adjusted in such a way that the temperature differential from the top to the bottom of the catalyst bed does not exceed 10°F. under steady state conditions.

Charging stock is introduced into the preheater as a liquid from a water jacketed charging burette through a capillary tube. The charging rate is adjusted by varying the pressure of the N_2 atmosphere above the oil in the burette. Air and H_2 are introduced into the reaction chamber through a gas manifold.

The exit gases, after passing through a West condenser and liquid products or synthetic crude trap, are diverted by a 3-way stopcock either into a gas collecting bottle, or through a tube of CuO combustion catalyst and a drying tower into an absorber filled with ascarite or any other CO_2 absorbant.

The operating conditions are as follows:

Preheater Temperature—830-850°F.

Catalyst Furnace Temperature—800°F. (±5°F.)

Charging Stock—Light East Texas Gas Oil

Charging Rate—5cc (±0.3%) (liq. cc @ 60°F.) per min. per 200 cc of catalyst

Pressure—atmospheric

Length of cracking period—10 minutes.

200 cc of catalyst are measured into the cracking tube, placed in the furnace and brought to cracking temperature under a stream of nitrogen. After flushing with N_2, the gas oil is passed over the catalyst for 10 min., and the products are collected in the glass trap and gas bottle. In order to effect a reproducible division between the gaseous and liquid products, the West condenser and trap must always be kept at a fixed temperature. It is our practice to hold both at 60°F.

At the end of this 10-minute run the catalyst is flushed by passing exactly 900 cc of N_2 through the tube into the gas bottle. The time taken for this flush is not critical, but the volume is, since it must be corrected for when calculating the gas yield.

Following the flushing period, the glass trap containing the liquid products is removed and replaced by a clean trap. The temperatures of the catalyst and the preheater are increased to between 950-975°F., and the catalyst deposit is burned off by a stream of air. The carbon in the regeneration fumes is completely converted to CO_2 by passage over CuO catalyst and is absorbed in ascarite. This regeneration usually takes from 2-4 hours.

Determinations and Calculations

1—*The gas gravity* (referred to air) is obtained by measuring the specific gravity of the mixture in the gas bottle and correcting for the amount of nitrogen used.

2—The *weight % gas* is calculated from the corrected volume and corrected specific gravity of the gas.

3—The *weight % catalyst deposit* is calculated from the amount of absorbed CO_2.

4—*Volume % Gasoline*—The yield of motor gasoline, which is the prime measure of the activity of a cracking catalyst, is determined by distilling the entire yield of liquid products or synthetic crude in a small glass still to a 410°F. cut point. The exact type of still used is not important, but it should be so designed as to have 5-10 theoretical plates, and a take off rate of approximately ½ cc/min. It is also desirable to use the trap in which the liquid products have been collected as the still pot.

For accurate catalyst evaluation it has been our custom to make a sufficient number of runs per catalyst to produce 3 gasoline yields within 1.5% of each other, 3 coke yields within 0.3% and 3 gas yields within 1.0%. The average of the acceptable results is taken as the final yield. The average yields on successive independent tests are reproducible to within about ±1% for gasoline, ±.05% for gas and ±.02% for coke. This fact is brought out in Table I, which summarizes the activity of one batch of catalyst as measured in two different laboratories over a period of two years.

As already mentioned in the introduction, the exact operating conditions for the test were chosen to simulate those in a particular type of commercial unit. When using the test for other purposes, it may be highly desirable to change such factors as the charging stock, catalyst temperature, amount of N_2 used to flush the catalyst, distillation cut point, etc. The only point which must be stressed, is that once a set of conditions is decided upon, it must be held to rigorously.

TABLE I

(Activity of a Single Batch of Cracking Catalyst, as Measured by the 200-cc Glass Case Method in Two Laboratories Over a Period of Two Years.)

Date	Laboratory	No. of Individual Runs	Gasoline Vol. %	Coke Wt. %	Gas Wt. %	Gas Gravity
March, 1942	A	150	47.0	3.2	9.5	1.55
Feb., 1942	B		46.4	3.4	9.7	1.54
July, 1942	A		46.7	3.3	9.8	1.56
Sept., 1942	A		46.2	3.3	9.7	1.59
March, 1943	A	25	45.9	3.1	9.4	1.48
July, 1943	A	29	47.1	3.2	9.8	1.55
July, 1943	B	7	47.4	3.6	10.0	1.46
Feb., 1944	A	34	47.2	3.6	9.5	1.57
Feb., 1944	B	4	47.8	3.8	9.1	1.54

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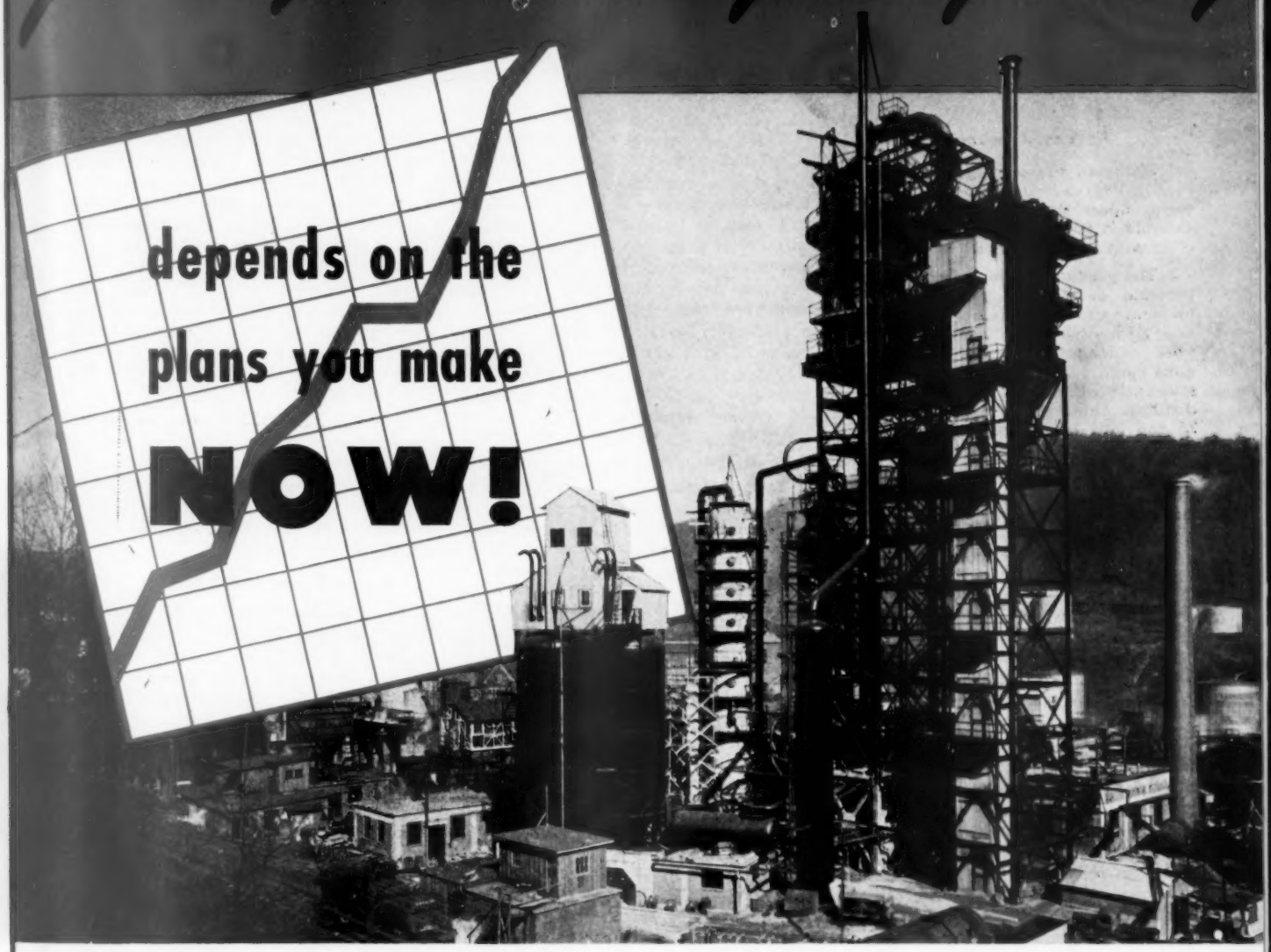

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Cracking of Kerosine and Gas-Oil From Perm Crude with Aluminum Chloride*

*By Yu. K. Yur'ev and I. A. Musaev***

Authors' Conclusions

1. Kerosine and gas oil fractions from Perm crude containing much aromatics yield, upon cracking with aluminum chloride, a distillate with a high content of aromatic hydrocarbons.

2. The product obtained from cracking kerosine contains a benzene fraction amounting to 4.25% and a toluene fraction amounting to 5.5% of the kerosine used as charging stock. These fractions contain 37 and 52% aromatics, respectively. Similar fractions of cracked distillate obtained from gas oil contain 23 and 30% aromatics, respectively.

3. The high contents of benzene and toluene in the obtained fractions of cracked products make it possible to directly nitrate them for preparation of nitro derivatives.

THE kerosine fraction of Perm oil from the field of Chusovskie Gorodki contains up to 60% by weight aromatics. Because of these aromatics and also the high content of sulfur compounds, it cannot be used as illuminating kerosine or as a fuel for internal combustion engines. It was previously shown by one of the present authors[1] that the high molecular aromatic hydrocarbons of the fraction 150-240° consists of mono- and disubstituted benzene homologs with long chains. Even if the Perm kerosine would be refined for any of the above mentioned two purposes (at an economic disadvantage) a material would be lost from which more valuable chemical products could be produced.

It is known from the literature that high molecular aromatic hydrocarbons react with aluminum chloride producing benzene and its closest homologs. Thus, cracking with aluminum chloride converted cumene[3] and cymene[4] into lower aromatics containing considerable yields[5]. From cumene a product was obtained containing 1.5% benzene, 27% toluene and 26% xylene. From cymene 0.8% benzene, 14.3% toluene and 7% xylene of the charge were obtained. Triphenylmethane, naphthalene and diphenyl were reported to give on cracking with aluminum chloride benzene as the main reaction product.

It was further shown[6] that the product of decomposition of diphenyl contains, in addition to much benzene (73.5%), also toluene (4%), cyclohexane (4%) and methylcyclopentane (18.5%). Completely hydrogenated condensed systems still containing at least one benzene ring such as tetralin[7] and octahydroanthracene gave[8], under the action of aluminum chloride, products containing benzene and its homologs. Thus aromatics of the series of benzene and naphthalene and their products of incomplete hydrogenation, when used as charging stock for cracking with aluminum chloride, give aromatics found in the cracked products.

Other classes of hydrocarbons found in petroleum fractions, i.e. cycloparaffins and paraffins, cannot be regarded as sources of formation of aromatic hydrocarbons in cracking with aluminum chloride for the following reasons. It was shown by various authors[9, 10, 11] that the action of aluminum chloride on cyclohexane and its homologs, as well as decalin, brings about isomerization processes accompanied by formation of products of extensive decomposition. It may, therefore, be concluded that neither cyclohexane or its homologs, nor condensed completely hydrogenated rings form aromatics when acted upon by aluminum chloride. This is confirmed by the results of a study carried out by one of the present authors on cracking of dicyclohexyl with aluminum chloride[12]. The obtained cracked distillate, in which aromatics could be formed from the cyclohexane ring only, contained no aromatic hydrocarbons at all.

For the above reasons the presence of small amounts of aromatic hydrocarbons in the fractions 60-150° of cracked products reported by Borisov et al[13] to have resulted from cracking dearomatized Grozny kerosine with 10% aluminum chloride should, in the opinion of the present authors, be ascribed to decomposition of still remaining aromatics and not to dehydrogenation of higher homologs of cyclohexane.

From the above literature review an assumption was made that cracking of Perm kerosine, in which aromatic hydrocarbons are abundant, in the presence of aluminum chloride will yield a cracked product with a high content of lower aromatic hydrocarbons.

Experimental Part

The kerosine fraction 150-300° of Perm oil had a d(20/4) 0.8675 and n(20/D) 1.4930. Its analysis by the method of aniline points showed a content of 60% by weight aromatics, 25% naphthenes and 15% paraffins. The sulfur content (Engler) was 2.49%.

The cracking experiments were carried out in a three-neck flask fitted with a stirrer and a mercury seal. The temperature was recorded in the reaction mixture as well as the evolved vapors. In each experiment 200 g. kerosine and 20 g. of finely powdered anhydrous aluminum chloride were used, i.e., 10% by weight aluminum chloride. In the first series of experiments the entire aluminum chloride was charged at once. In the second series it was charged in 5 g. portions added every 1.5-2 hours.

The temperature of the reaction mixture was regulated in such a way that the temperature of the vapors did not exceed 150°. The distillation of the cracked products began when the temperature of the reaction mixture reached 160°. This temperature gradually increased, and when it reached 230-240°, which required 6-8 hours, the process was complete.

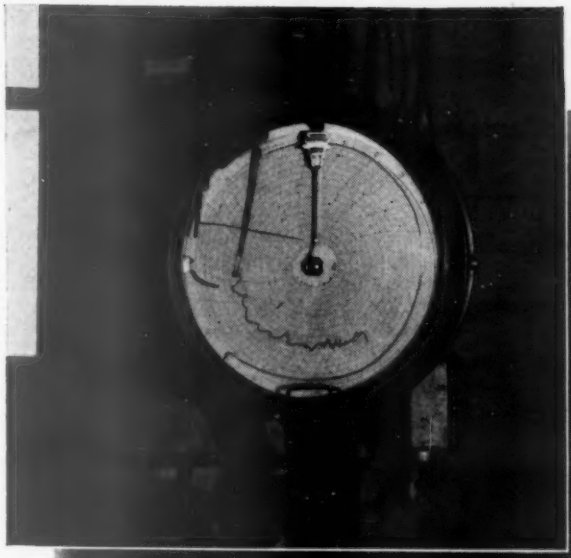
Considerable amounts of hydrogen sulfide were contained in the liberated gases. The cracked distillate was washed with water, 10% alkali, again with water, dried over calcium chloride and was twice fractionated under a 50 cm. long Vigreux column. It did not discolor permanganate solution. In both series of experiments a carbonaceous mass was left in the reaction flask and in addition 9-10% liquid residue. In the first series this residue was left uninvestigated. In the second series, to which aluminum chloride was added in portions, this res-

This article is the first of several translations from Russian scientific literature to be published in the Technical Section of NATIONAL PETROLEUM NEWS. With the co-operation of the Petroleum Division of the American Chemical Society these articles have been selected from Russian journals as reporting on research work of interest to petroleum technologists in this country. Translations have been made by Dr. J. G. Tolpin of Universal Oil Products Co., Chicago.

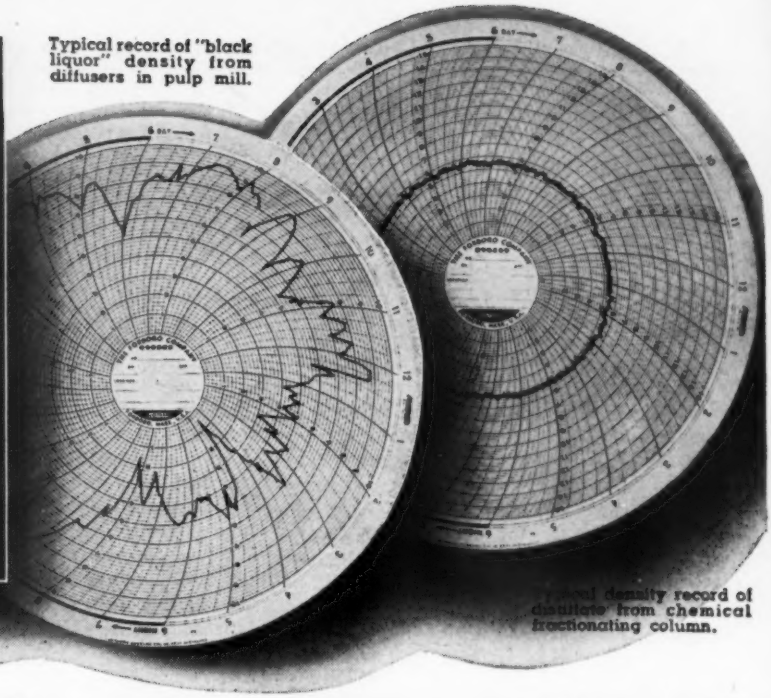
The facts and opinions in these translations are solely those of the original authors cited. Universal Oil Products Co. does not necessarily endorse the statements made.

*A complete translation of the original article appearing in Neftyanoe Khozyaistvo (Petroleum Industry), 1936, No. 2, pgs. 56-59. Translation is by Dr. J. G. Tolpin, Universal Oil Products Co., Chicago.

**N. D. Zelinskii Laboratory of Organic Chemistry, Moscow State University.



Typical record of "black liquor" density from diffusers in pulp mill.



Typical density record of distillate from chemical fractionating column.

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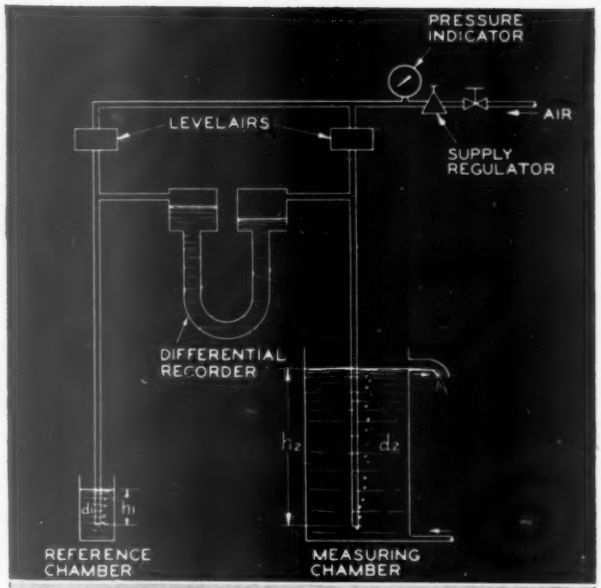

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idue was added to the cracked distillate before the fractionation and was subjected to investigation.

In the obtained cracked products the aromatics were determined by the method of aniline points (solidification point of the aniline, −6.4°). The coefficients determined by Tilicheev and Dumskaya[14] for fractions boiling up to 150° and by Sakhanov and Virabyants[14] for fractions boiling over 150° were used in these tests. From the fractions with end point 150° the aromatic hydrocarbons were removed by three consecutive treatments with half their volume of sulfuric acid containing 7% sulfur trioxide. This treatment consisted of shaking for half an hour in a shaking machine followed by a two hour settling period. For the fractions boiling above 150° two volumes of 100% sulfuric acid were used in a similar treatment. The contents of naphthenes and paraffins were calculated from the aniline points of the dearomatized fractions with the aid of Tilicheev's coefficients[14] for fractions with end point 150° and Carpenter coefficients[15] for fractions 150-300°. The results of cracking of Perm kerosine with 10% aluminum chloride and the chemical composition of the obtained fractions are shown in Tables 1 and 2.

A comparison of the results obtained from the two series of experiments shows that when aluminum chloride is added in portions, less coke is formed and the yield of cracked distillate is considerably higher (53.5 against 42%). This is due to the fact that under the action of smaller amounts of aluminum chloride reactions of dehydrogenation and condensation of the dehydrogenated molecules is not as vigorous as when the entire aluminum chloride is added at once. This results in a lower rate at which aluminum chloride becomes enveloped with carbonaceous products of extensive decomposition of the charge.

The yield of light products boiling below 150° is also higher when aluminum chloride is added in portions (30 instead of 22.5%). The yield of benzene and toluene fractions is approximately the same, the toluene fraction amounting to 5-5.5% and the benzene fraction, to 4-4.2% of the kerosine charge. The chemical composition of these fractions is very close and in complete agreement with the expected results. The products are very rich in aromatics and in the benzene fraction of the second series of experiments the content of aromatics was 37%, that in the toluene fraction 52% (Table 2).

The benzene and toluene fractions liberated from the cracked distillate in the

TABLE 1—Cracking of Perm Kerosine in the presence of 10% Aluminum Chloride Added in One Portion. Yield of Cracked Distillate, 42%. Liquid residue in the flask, 10%

Fraction, °C.	Content of the fraction in per cent of: obtained cracked distillate	Content of the fraction in per cent of: the kerosine used	n(20/D): before removal of aromatics	n(20/D): after removal of aromatics	d_{20}: before removal of aromatics	d_{20}: after removal of aromatics	Critical temperature of solution in aniline, ° C.: before removal of aromatics	Critical temperature of solution in aniline, ° C.: after removal of aromatics	Per cent of: aromatics	Per cent of: naphthenes	Per cent of: paraffins
to 60	3.9	1.65	.....	.....	.....	.....	...	...	..	..	..
60—95	9.6	4.0	1.4342	1.3992	0.7674	0.7102	18.2	55.8	43	26	31
95—122	12	5.0	1.4555	1.4135	0.7986	0.7387	4.5	56.6	56	24	20
122—150	31.4	13.1	1.4656	1.4212	0.8160	0.7518	4.5	61.6	65	17	18
Residue over 150	...	10.35	.....	.....	.....	.....	..	...	..	..	..
Losses	...	7.9	.....	.....	.....	.....	...	...	..	..	..
Cracked residue in the flask	...	9	.....	.....	.....	.....	...	...	..	..	..
Carbonaceous mass and gases	...	49	.....	.....	.....	.....	...	...	..	..	..

TABLE 2—Cracking of Perm Kerosine in the Presence of 10% Aluminum Chloride Added in Portions. Yield of cracked distillate, 53.5%. Liquid residue in the flask, 10%

Fraction, °C.	Content of the fraction in per cent of: obtained cracked distillate	Content of the fraction in per cent of: the kerosine used	n(20/D): before removal of aromatics	n(20/D): after removal of aromatics	d_{20}: before removal of aromatics	d_{20}: after removal of aromatics	Critical temperature of solution in aniline, ° C.: before removal of aromatics	Critical temperature of solution in aniline, ° C.: after removal of aromatics	Per cent of: aromatics	Per cent of: naphthenes	Per cent of: paraffins
to 60	3.9	2.5	1.3730	.....	0.6489	.....	...	...	..	..	..
60—95	6.7	4.25	1.4257	1.3980	0.7530	0.7019	24.6	56.8	37	27	36
95—122	8.7	5.5	1.4521	1.4120	0.7957	0.7131	7.7	56.8	52	27	21
122—150	29.2	18.5	1.4661	1.4210	0.8188	0.7505	1.7	61	68	17	15
150—200	25.2	16	1.4571	1.4291	0.8478	0.7652	34.4	69.8	48	21	31
200—250	11.2	7.1	1.4509	1.4378	0.8015	0.7811	68.6	80.8	20	20	60
250—300	4.7	3	1.4651	1.4415	0.8213	0.7898	75.2	89.4	25	14	61
Residue over 300	...	1.65	.....	.....	.....	.....	...	...	..	..	..
Losses	...	5	.....	.....	.....	.....	...	...	..	..	..
Carbonaceous mass and gases	...	36.65	.....	.....	.....	.....	...	...	..	..	..

TABLE 3—Cracking of Perm Gas Oil With 10% Aluminum Chloride Added in Portions. Yield of cracked distillate, 32.5%. Semi-fluid residue in the flask, 6%

Fraction, °C.	Content of the fraction in per cent of: obtained cracked distillate	Content of the fraction in per cent of: on the gas oil used	n(20/D): before removal of aromatics	n(20/D): after removal of aromatics	d_{20}: before removal of aromatics	d_{20}: after removal of aromatics	Critical temperature of solution in aniline, ° C.: before removal of aromatics	Critical temperature of solution in aniline, ° C.: after removal of aromatics	Per cent of: aromatics	Per cent of: naphthenes	Per cent of: paraffins
to 60	5.8	1.8	1.3651	.....	.....	.....	...	...	..	..	..
60—95	14.1	4.3	1.4125	1.3980	0.7365	0.7081	32.6	52.3	23	41	36
95—122	17.7	5.4	1.4334	1.4132	0.7702	0.7394	28.4	53.8	30	33	37
122—150	21.7	6.6	1.4512	1.4210	0.7987	0.7550	22	60.1	46	29	25
150—200	25	7.6	1.4616	1.4445	0.8170	0.7757	31	65.6	48	32	20
Residue over 200	...	2.5	.....	.....	.....	.....	...	...	..	..	..
Losses	...	3.3	.....	.....	.....	.....	...	...	..	..	..
Liquid residue in the flask	...	6	.....	.....	.....	.....	...	...	..	..	..
Carbonaceous mass and gases	...	61.5	.....	.....	.....	.....	...	...	..	..	..

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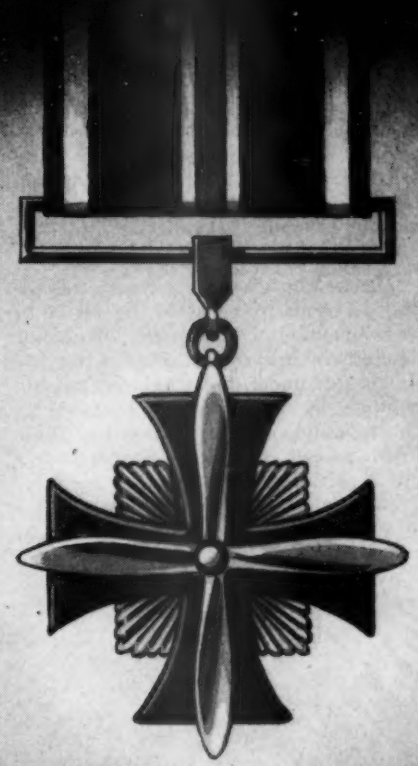

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experiments in which the entire aluminum chloride was added at once contains somewhat more aromatics, i.e., 43 and 56% respectively. The considerable yield of the xylene fraction amounting in the first series of experiments to 13.1% and in the second series to 18.5% of the kerosine used as charge, in connection with the very high yield of aromatics contained in that fraction, i.e. 65-68%, points to substantial amounts of high molecular disubstituted benzene homologs being present in the Perm kerosine. It is also possible that the xylene fraction is accumulated partly through migration of radicals of monosubstituted homologs.

The fractions 150-300° from the second series of experiments are interesting from the point of view of the change aluminum chloride exerted on the chemical composition in comparison with the fractions of the initial kerosine. The content of aromatic hydrocarbons in these fractions ranges from 20-48% against a 60% content of aromatics in the corresponding fractions of Perm crude oil; the content of paraffin reaches 60%, while the crude contains 25-27% of these fractions[16].

Cracking of Perm kerosine with aluminum chloride also brings about a vigorous desulfurization[17]. The cracked products from the second series of experiments (cracked distillate as well as the liquid residue in the flask) contained 0.3% sulfur as indicated by an Engler analysis.

It may be assumed on the basis of the results of cracking Perm kerosine under conditions of gradual addition of up to 10% aluminum chloride, that when this process is carried out under still milder conditions and also using smaller portions of aluminum chloride, a cracking distillate can be obtained with a still higher content of aromatic hydrocarbons and on the other hand a larger yield of a desulfurized liquid residue characterized by a change in chemical compositon, as well as a lower amount of carbonaceous mass. Milder conditions of cracking may apparently bring the total yield of cracked product obtainable from Perm kerosine to 70-75%.

Perm gas oil, fraction 300-400°, was next used as a charging stock. This fraction was separated by a vacuum distillation and had an end point n(20/D) 1.5377 and d(20/4) 0.965. The chemical composition follows:

Aromatics	65%
Naphthenes	23%
Paraffin	12%
Sulfur (Engler)	4.97%

Cracking of this fraction was regarded as of substantial interest. It was carried out by the above described method, using 10% aluminum chloride, which was added in portions. Distillation of cracked distillate began when the temperature in the reaction flask reached 260° and that in the vapors 45°. The cracked distillate was treated as described above and analyzed, giving the data shown in Table 3.

The yield of cracking distillate obtainable from Perm gas oil was smaller than in the preceding series of experiments—32.5%. The benzene and toluene fractions are similar in size to those obtained from kerosine, but contain less aromatics. However, the latter still constitutes a very substantial percentage of the product (23 and 30%, respectively). The sulfur content (Engler) of the cracking distillate was 0.26%. The predominant amount of cracked products consisted of carbonaceous mass.

The results should apparently be explained by the presence in the gas oil of large amounts of condensed polynuclear aromatic hydrocarbons that are being hydrogenated under the action of aluminum chloride by the hydrogen liberated in decomposition of some molecules. These hydrogenated compounds further undergo a partial dehydrogenation with resulting junction at the point of elimination of hydrogen forming high molecular condensation products which are later converted into a carbonaceous mass in the course of further dehydrogenation.

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Synthetic rubber and synthetic fibers, substances closely related to plastics, have also received much attention. An 8-page appendix lists nearly 300 familiar plastics and related materials, giving their trade names, chemical types, and manufacturers.

Both authors are well known in the petroleum industry. Mr. Weil, a chemical engineer with Gulf Research and Development Co., Pittsburgh, has written many articles on technical subjects connected with petroleum. He was co-author of the series "ABC of Chemical Derivatives from Petroleum," which appeared in the Technical Section of National Petroleum News last year. Mr. Anhorn is also with Gulf Research and Development Co., as a research chemist.

Copies of *"Plastic Horizons"* (5½ x 8 in., 169 pages, stiff cloth binding) can be obtained from the Book Department of National Petroleum News, 1213 West Third Street, Cleveland 13. The price is $2.50.

° ° °

Geology of East Indies

The July, 1944, issue of the Quarterly of the Colorado School of Mines contains "Miocene Foraminifera from Sumatra and Java, Netherlands East Indies", by Dr. L. W. LeRoy, instructor in geology at the School of Mines. This publication comprises 113 pages.

The two papers included supplement three papers by the same author, dealing with the smaller Tertiary Foramanifera of the Netherlands East Indies which appeared in the Quarterly of January, 1941.

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Co-operative Attack Launched on Corrosion Problem in Condensate Well Equipment

CORROSION of equipment in high-pressure condensate wells in certain fields has become a serious problem for the well owners. As yet the causes are enough of a mystery to make a plot for an oil field "who dun' it." The condition is extensive enough, however, that the Natural Gasoline Assn. of America has led in organizing a joint research program to attempt to determine the causes and find a cure. Co-operating are interested oil companies and the Division of Production of the American Petroleum Institute and the U. S. Bureau of Mines.

The natural gasoline association has raised $20,000 to carry on active research this year, and Battelle Memorial Institute, Columbus, O., has been retained to conduct laboratory investigations. Dr. H. A. Pray of the institute staff has been assigned to the work. He now is on an extensive tour, inspecting the condensate fields where corrosion has been found. Thomas S. Bacon, Lone Star Producing Co., Dallas, chairman of the association's high-pressure gas corrosion committee, will be general supervisor for the project. He also is chairman of an A.P.I. subcommittee on corrosion. The research program is expected to continue for the next several years, according to W. F. Lowe, secretary of the Natural Gasoline Assn.

The association, at a meeting in Houston June 15, also considered placing some phases of the investigation in the hands of educational institutions in the Southwest, as field studies could be made more conveniently by them. Their work would be co-ordinated with that at Battelle Institute.

In the research project it is planned to use the data from field experiments now underway. These represent the efforts of several individual companies. Some of the condensate wells, which cost around $150,000 each to drill, have been set aside for research purposes. This alone represents a major expense to the individual company, because the volume of effluent from these wells will be reduced while the experiments are under way. Individual companies are also reported planning to spend thousands of dollars for private investigations. The findings will be made available to the association's research group at need.

Through the co-operation of the Bureau of Mines, important data will be placed at the disposal of the gasoline association's investigators. In addition, the Bureau's personnel will be made available for technical consultation. The A.P.I. has similarly arranged to supply any of its data desired by this research staff. These arrangements will preclude parallel and wasted effort by any of the agencies involved in the project. The data arrived at will be made available as early as possible to all parties concerned.

The research project had its inception at a meeting of directors of the N.G.A.A. at the annual convention in Dallas last April. Action approving the project was based on a report presented by Mr. Bacon and the association's technical committee. The report, which showed the seriousness of the corrosion problem in some of the condensate wells, was compiled from data developed by the committee.

Well Corrosion Long a Problem

Corrosion in wells long has been an oil industry problem, but usually the cause of corrosion has been apparent even if not easily controlled. In condensate wells, however, the corrosion is particularly serious in that the fluids are under extremely high pressure, making the well difficult to control if it should go "wild" because of failure of tubing, casing or Christmas tree through corrosion. Expense of replacing damaged equipment also is high for the same reason.

In addition to this obvious economic loss is a still greater potential loss. If the well does go "wild" and releases gas and condensate to atmosphere, the phenomenon of retrograde condensation may cause otherwise producible hydrocarbons in the reservoir to be irretrievably lost. Moreover, this would damage other wells in addition to the one which failed and might well imperil millions of dollars worth of wells and recovery installations.

The cause of the corrosion in the high-pressure condensate wells is a mystery. Reports from the fields indicate there apparently is no known corrosive agent present except possibly carbon dioxide. However, water produced with the hydrocarbons from the wells has been found to contain iron in excess of that found in bottom-hole samples and presumably coming from tubing, well-head controls and flow-lines. There are as yet no reports from oil companies mentioning similar corrosion attacks in the cycling plants, but this source of corrosion is being watched.

Among the other possibilities, erosion of metal by the liquid particles in the swiftly moving fluid has not been entirely eliminated from the field of suspects. Some authorities advance the possibility this may be a secondary rather than primary cause of trouble. Also, galvanic effects resulting from electrically-connected dissimilar metals cannot be dismissed from consideration as one source of the trouble.

Following are excerpts from papers presented before the April, 1944, meeting of National Assn. of Corrosion Engineers in Houston, which discuss both technical and economic aspects of the problem.

The Importance of Internal Corrosion of Tubing

By T. W. Johnson
Union Producing Co., Shreveport, La.

"The replacement of equipment that has corroded to a point where failure has occurred has proved to be very expensive in a number of instances. Also, in high pressure wells where the tubing has parted or large holes have developed near the top of the string it may be very difficult to kill the well preparatory to removing the tubing.

"In one well about 10,300 ft. deep corrosion had resulted in a hole in the tubing about 300 ft. from the surface. In order to kill the well, it was finally necessary to snub under pressure about 6000 ft. of 1¼-in. diameter tubing through the 2½-in. diameter tubing, and pump mud through the smaller size tubing. Operations such as these are expensive and must be performed with caution since there is no way at present of determining what piece or pieces of equipment are near the point of failure, due to internal corrosion, and where the application of additional pressure during the process of killing the well would be dangerous."

Some Studies of Water Produced By High Presure Wells

By Walter F. Rogers
Gulf Oil Corp., Houston

"Corrosion of oil well subsurface equipment is as old as the industry, and is a subject which has always received some attention. Seldom, however, have these corrosion problems approached the economic importance of corrosion of high-pressure well equipment. This economic importance is largely latent but is nevertheless a real possible danger.

"The value of the physical equipment involved may not be too large if the only losses are portions of the Christmas tree or adjacent equipment. However, the large damages which may result if a high pressure well blows wild as the result of corrosion attack are recognized by the industry. These facts regarding the seriousness of this type of corrosion are well known and make it imperative that the oil industry develop a solution as rapidly as possible."

The Need for a Method of Detecting Internal Corrosion

By T. W. McGuire
Cotton Valley Operators Committee, Cotton Valley, La.

"During the past 6 months 5 strings of tubing parted in this (Cotton Valley, La.) field. In all but one case, the tubing parted either within one joint from

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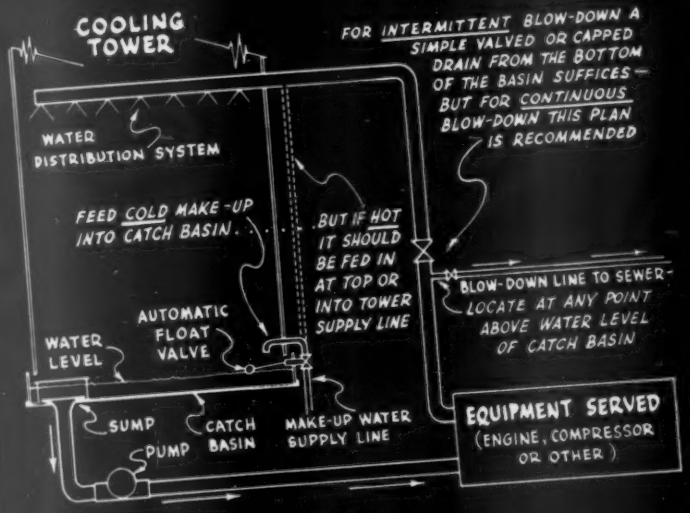
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BUT IF HOT IT SHOULD BE FED IN AT TOP OR INTO TOWER SUPPLY LINE
BLOW-DOWN LINE TO SEWER— LOCATE AT ANY POINT ABOVE WATER LEVEL OF CATCH BASIN
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SUMP
PUMP
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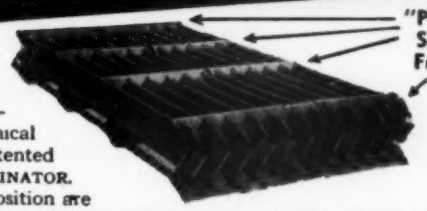

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the top or in the tubing hanger. Two strings of tubing were pulled due to pronounced corrosion in the well head connections. Tubing from these wells was pitted due to corrosion and replacements were necessary for several joints below the tubing hanger. Within recent months two flow lines ruptured and, although not directly attributed to corrosion, there was evidence of the action.

"Well head connections can be inspected periodically and, in most cases conveniently, without great cost. Necessary changes and replacements can then be made at minimum expense or operating cost. Tubing cannot be inspected without pulling it from the well. To do so it is necessary to kill the well, rig up with tools, pull tubing, make necessary inspection and replacements, re-run the tubing and wash or swab the well to production. This represents quite an outlay of expenditure and is not economically feasible to include in operations as a routine check, although periodic inspection of tubing is considered warranted in some fields."

". . . Conditions now existent in the well bore in high pressure gas wells leave the operator with a feeling of insecurity relative to practical control of the well. It is an ill feeling to check a well and find the tubing to be parted. Killing a well with parted tubing is considerably more injurious to the sand than killing one with tubing intact. More expense is involved in replacing the tubing and doing the necessary remedial work. Usually very little tubing is usable for retubing a well after it has parted, while tubing replaced in the early stages of corrosion requires only a few joints.

"A complete survey of tubing condition in the Cotton Valley field would allow us to do necessary work when corrosion is in evidence. Tons of critical material could unquestionably be saved by knowledge of the well condition. Isolating and frequent checking of those wells that reflect most pronounced corrosive effect would also be helpful in determining a cause of the condition. So far we have been unable to tell definitely which wells are affected by corrosion, since some wells, upon having tubing pulled for various types of remedial work, reflect no corrosion in tubing."

Corrosion of High-Pressure Well Equipment*

Nature of This New Form of Corrosion and Resulting Damages is Described, to Emphasize Importance of the Co-operative Effort Launched to Find a Solution

By Thomas S. Bacon**

A new problem of corrosion of high-pressure production equipment is described, which affects tubing strings, Christmas tree fittings, flow valves and flow lines in condensate wells in many fields, causing equipment failures. Methods of checking field equipment for the presence of this corrosion are discussed.

Various remedial practices are described, although no entirely satisfactory remedy has been suggested. The advantages that might be obtained by the use of satisfactory alloys are emphasized. It is concluded that this new form of corrosion presents a real problem to the petroleum industry and warrants co-operative efforts toward a satisfactory solution.

THE petroleum industry has recently realized the existence of a new problem occasioned by high-pressure, gas-distillate operations. This problem was first publicly described slightly more than a year ago. At that time it appeared that the problem was not widespread, but it has attained very important proportions during the past few months.

A paper presented before the Natural Gasoline Assn. of America convention in Dallas in April, 1943, described internal corrosion of Christmas tree fittings that had been observed in the Opelika field, Henderson county, Texas. This corrosion occurred on the internal surfaces of pipe, valves, and fittings in the Christmas tree assembly and was so severe as to have weakened some of the equipment almost to the point of failure. This particular type of corrosion appears to be unique in that it may be highly localized, causing serious weakening of one end of a length of pipe, while not affecting the other end appreciably.

It also occurs in the absence of any known corrosive agents with the possible exception of carbon dioxide. This particular form of corrosion is extremely unpredictable on the basis of present information. In at least some instances, some wells in a given field will be entirely free from any sign of corrosion, while other wells will be corroded with extreme rapidity.

The appearances of the corroded surfaces vary widely. Some typical surfaces show severe attack at points of high turbulence in the gas stream. In another form of corrosion the internal surfaces of the fittings are fairly smooth and the internal surfaces of the nipples are attacked only slightly, whereas serious weakening has been caused by removal of the threads on the nipples and by removal of the adjacent threads in the fittings.

The appearance of some attacked surfaces might lead to the assumption that erosion plays an important part in the removal of metal. The experience of the Lone Star Producing Co. has indicated that the removed metal is largely in chemical solution in the produced water in most cases. This experience and the fact that large pits covered with mechanically weak mill-scale have been found adjacent to the roughened surfaces indicates that corrosion is probably the predominant cause of metal removal.

This form of corrosion is particularly dangerous because failure of the high-pressure equipment involved might result in very serious property damage. Several flow lines have failed in service. However, in each case of flow line failure which has been reported to date, it has been possible to close the well in before the Christmas tree was seriously damaged. Failure of a master valve under these conditions might conceivably make it impossible to control the well except by the slow and expensive process of drilling a directional well. This expense and the economic waste occasioned by the escape of reservoir fluids to the air and the possible retrograde condensation losses in the reservoir could easily be sufficient to absorb a considerable portion of the anticipated return from a recycling project.

The economic cost of this type of corrosion is also amplified when tubing fails in the well. Five strings of tubing have been reported as parting in the Cotton Valley, La., field in 6 months due to this corrosion.

The Union Producing Co. has lost three strings of tubing in other Louisiana fields and reported an expenditure of $71,500 in retubing one of these wells. In addition, such wells in which tubing strings have failed are extremely difficult to kill, even though the surface fittings are intact, and any killing process may result in damage to the producing formation. The Lone Star Producing Co. has had at least one case of tubing failure that has been ascribed to this form of corrosion.

In order to be on the safe side, it should be assumed that Christmas tree fittings have been appreciably affected by corrosion on any well in which the tubing has failed due to corrosion. The killing job should, therefore, be handled with extreme caution. In fact, some experience indicates corrosion of the Christmas tree may occur without appreciable corrosion of the tubing. The

*Presented before Southwestern District, Division of Production, American Petroleum Institute, Houston, June 13-14, 1944.

**Research Engineer, Lone Star Producing Co., Dallas; Chairman High Pressure Gas Corrosion Committee, of Natural Gasoline Assn. of America.

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Christmas tree on the Allyn No. 1 well at Opelika was found to be badly corroded about a year ago, and it was decided to inspect the tubing in this well to determine the degree of corrosion in the tubing.

The corroded Christmas tree was replaced, and the well was killed and tubing pulled. Inspection of the tubing showed it to be in excellent condition, with only very slight corrosive attack on the bottoms of the tubing joints. The tubing was re-run, and the well brought back into production. The total cost of this inspection was $5735. On the other hand, in at least one well the tubing failed before the Christmas tree showed corrosive attack.

In view of the above considerations, operating personnel have shown an active interest in this problem and in its possible solution. However, it has been difficult to obtain a true picture of the magnitude of the problem, due to the number of fields involved, and due to the short periods of operation of many important distillate fields. The first step toward concerted action on the solution of this problem was taken at the meeting of the American Petroleum Institute held in Chicago in November, 1943. The Southwestern District Topical Committee on Materials was assigned the study of this problem, and the preparation of a paper discussing the problem to be presented at the 1944 spring meeting of the Southwestern District.

Thirty-five representatives of interested companies met informally in Dallas in December, 1943, to discuss the magnitude of the problem and possible methods of procedure in attacking it. Evidences of this type of corrosion were reported at this meeting as having been definitely observed in only 7 fields. Close observations of 7 other fields, some of which had been producing for many years, showed this type of corrosion to be absent. The problem appeared to be of such importance to those attending this meeting that an independent committee was organized to investigate the problem, and to serve as a clearing-house for information regarding the problem, and ideas concerning its solution. There was no information available at this meeting regarding the action of the A.P.I. in this connection. This independent committee has recently disbanded, in view of the work of other committees on the same subject.

G. H. Calhoun, chairman of the Southwestern District Topical Committee on Materials of the A.P.I., appointed a special Subcommittee on Corrosion of High-Pressure Production Equipment in March, 1944. Its objective was "to determine causes of, and select remedies for, corrosion of high-presure production equipment, such as tubing, well-head connections, flow lines, etc., particularly in high-presure condensate wells." The initial efforts of this subcommittee have been directed toward obtaining further information regarding the extent of the problem.

Table 1 lists fields in which corrosion has been evidenced either by failure of equipment, by corrosion severe enough to cause replacement of equipment or by analyses of produced water samples for iron content. The table is largely based on the results of a survey of operations of companies having representation on the sub-committee.

It should be emphasized that this list of fields in which signs of corrosion have

TABLE I—Some High-Pressure Fields in Which Corrosion Occurs

No.	Field	County	State	Operator	Year Field Discovered	Evidences of Corrosion
1	Bateman Lake	St. Mary	La.	Texas	1937	Replacement of Christmas tree valves and nipples
2	Brushy Creek	Lavaca	Texas	Shell	1941	Surface fittings attacked
3	Buffalo	Leon	Texas	Lone Star Producing	1934	Corrosion of bottom hole chokes, requiring replacements
4	Cayuga	Anderson	Texas	Seaboard	1934	Replacements of valves and Christmas trees
5	Chapel Hill (Paluxy only)	Smith	Texas	Shell Sun	1938	Choke beans cut out. Surface fittings attacked
6	Cotton Valley	Webster	La.	Cotton Valley	1922	Failure of two flow lines and five strings of tubing
7	Delarge	Terrebonne	La.	Union Producing	1938	Tubing failure
8	Grapeland	Houston	Texas	Lone Star Producing	1936	Replacement of Christmas tree valves, fittings, and nipples
9	Hester	.....	La.	Humble	....	Well-head fittings corroded
10	Katy	Waller	Texas	Stanolind	1935	No evidences of corrosion in 1942. Surface fittings found to be attacked in 1944. Many valves will require replacement
11	Lake Mongoulois	St. Martin	La.	Texas	1939	Replacement of Christmas tree valves and nipples
12	LaPice	St. James	La.	Shell	1939	Replacements of valves on Christmas trees
13	Lisbon	Claiborne	La.	Union Producing	1936	Tubing failures
14	Long Lake	Anderson	Texas	Seaboard	1933	Replacements of valves on Christmas trees
15	North Houston	Harris	Texas	Distillate Production Corp.	1938	Chemical Analysis*
16	North McFaddin	Victoria	Texas	Gulf	1937	Chemical Analysis*
17	Old Ocean	Brazoria	Texas	Abercrombie	1934	Tubing failures
18	Opelika	Henderson	Texas	Lone Star Producing	1937	Replacements of Christmas tree valves and nipples
19	Orchard	Ft. Bend	Texas	Gulf	1936	Replacement of three flow lines after three years of service
20	Red Fish Reef	Chambers	Texas	Humble	1940	Bottom hole chokes corroded
21	Texana	Jackson	Texas	Gulf	1939	Chemical Analysis*
22	Lirette	Terrebonne	La.	Humble	1937	Well head fittings corroded
23	Willow Springs	Gregg	Texas	Lone Star Producing	1938	Replacements of Christmas tree valves and nipples. (Also probable cause of failure of one tubing string)

*Note: When produced water contains 100 p.p.m. of iron or more, fields are included in Table 1 on basis of "Chemical Analysis."

TABLE 2—Corrosion Experiences of Reporting Companies

Company	Total Fields Reported Operated at Pressures above 1500 lb. sq. in.	Number of Fields Not Showing Corrosion	Number of Fields Showing Corrosion	% of Fields Inspected Showing Corrosion
A	4	0	4	100%
B	9	3	3	50%
C	3	0	2	100%
D	4	1*	3†	75%
E	10	6	4	40%
F	14	13	1	7%
G	10	9	1	10%
Total		32	18	36%

*Based on chemical analysis only.
†Two fields classed as corrosive on basis of chemical analysis only.

been observed does not include all fields in which signs of corrosion might be observable with careful examination. It has been the practice in the past to assume that sweet gas wells should be free of internal corrosion, and most operators have proceeded on that theory until the past few months. Therefore, many fields have not been examined carefully for signs of this corrosion. The only possible way in which this corrosion could be evidenced in these fields would be by failure of equipment. Even with severe corrosive attack, failure of equipment will result only after prolonged periods of exposure, so there is reason to believe that additional fields will show corrosion in the future. Further, the data in Table 1 have been obtained from a few companies only and no attempt has been made to survey all operators in compiling these data.

In spite of the lack of complete data regarding the occurrence of this corrosion, the frequency of its occurrence as indicated in Table 1 is sufficient to indicate that it definitely presents a real operating problem to the industry.

Table 2 is of interest in indicating the frequency of corrosion as shown by the reporting companies. Here again, the data are incomplete, but the possibility of finding corrosive conditions in a new field is emphasized. The corrosive conditions have been shown to occur with such frequency that the possibilities of finding appreciable corrosion in any high-pressure field cannot be overlooked with safety.

Corrosion Tests

The above discussion indicates the need for some sure method of detecting the presence of this corrosion so that remedial measures may be taken before corrosion has proceeded far enough to be dangerous. Accurate tubing calipers that could be run under pressure would be of extreme value in this connection, although, unfortunately, no such instrument is commercially available to the knowledge of the writer. Visual inspection of surface fittings seems to be the most practical way at present to determine the degree of corrosion in these fittings. Chemical tests for dissolved iron in water produced by each well are at least indicative of the likelihood of the presence or absence of serious corrosion.

In the writer's experience, corrosion will be almost negligible in wells showing less than 50 parts per million of iron in the produced water. Wells showing iron concentrations of from 75 to 100 parts per million in the produced water should be watched for other signs of corrosion and wells showing iron contents in excess of 300 parts per million should be carefully inspected every three months.

Properly supervised chemical tests for iron in produced water samples are believed to be valuable in safeguarding operations of these high-pressure properties. Water samples should be obtained with care and at frequent intervals and, in the writer's opinion, should be acidified with nitric acid as soon as taken to insure that all iron remains in solution. If it is desired to record the pH value of the produced water, this may be done before addition of the nitric acid by the use of a field kit for the determination of pH. Iron may be lost from solution in these samples on standing even when reasonable precautions have been taken to prevent access of air to the samples, particularly if the samples are of high iron content.

It is the present practice of the Lone Star Producing Co. to install necessary sample taps wherever it is felt that additional chemical analyses are desirable. By determining dilution caused by condensation of additional water vapor from the gas on the basis of the chloride content of the water samples from any one well, it is possible to correlate iron contents of the various samples and, therefore, determine the amount of iron dissolved from the system between each pair of sampling points, if the volume of water produced at any sampling point is known.

The question of concentration of iron in the liquid connate water entering the produced stream from the formation is of importance in this connection. The iron/chloride ratios of ordinary connate waters may be of value in estimating the effect of dissolved iron in the produced connate water on the iron content of any water sample obtained at the surface. The Lone Star Producing Co.'s experience indicates that iron dissolved in the connate water amounts to less than 5 parts per million in the average surface sample.

Chemical tests, coupled with a knowledge of the amount of liquid water in the produced stream at the point of sampling, are of value in estimating the total weight of iron removed from the pipeline system by corrosion. However, these tests do not indicate whether this weight of iron has been removed uniformly from the total exposed metal surfaces to give very slight penetration of the pipe walls, or whether the corrosive attack has been highly localized, resulting in serious weakening of a part of the metal structure. Therefore, any chemical tests showing appreciable iron concentrations should be supplemented by other methods for determining the location of the corroded surfaces, and for determining the depth of penetration of the metal walls.

It may be assumed that gas in the reservoir is saturated with water vapor under the existing conditions of temperature and pressure. Some of this water vapor will be condensed to liquid water as the gas is cooled during production. The actual volume of water condensed will depend on reservoir conditions and on flow line conditions, but will be of the order of magnitude of 1 barrel per million cubic feet of gas. If it is assumed that water samples at the well-head show a dissolved iron content of 100 parts per million, the production of each billion cubic feet of gas would result in the production of 35 pounds of iron in solution in the water associated with this gas. If this iron is removed uniformly from the interior surface of 10,000 ft. of tubing, penetration of the tubing will be negligible. However, if all of this corrosion is concentrated in the top joint of tubing, this joint will be seriously weakened.

Water samples may readily be obtained from the inlet separator at any recycling plant, and the amount of iron in these samples can be determined at small cost. The total weight of iron per day removed from the system by the water leaving the inlet separator can then be calculated if the volume of water drained from the separator is known. If this weight of iron is negligible, absence of corrosive attack of the production system is indicated. But, if this weight of iron is appreciable, the likelihood of corrosive attack of some part of the production system is indicated.

Occasionally, samples of the produced water will contain insoluble iron compounds. Such cases that have been reported are very few, and are difficult of explanation. The presence of insoluble iron compounds in the produced water under flowing conditions will, of course, interfere with any conclusions based on analyses of the water samples, as the iron precipitates will vary in concentration in the water sample, depending on the sampling system. If iron sludge or deposits of insoluble iron compounds are found at any place in the system, it is believed likely that corro-

sion will be found at some place upstream from the sampling point.

The industry has not yet standardized on any remedy for this type of corrosion. Many operators are presently relying on visual inspections of all equipment that is suspected of attack to reveal any dangerous condition. Any equipment that is found to be seriously weakened in the course of these inspections is replaced by new equipment of the same type. Other operators are specifying that all master valves in high-pressure service be lined with corrosion-resisting alloys. Other operators are injecting chemicals into the flow system at some point in an effort to eliminate corrosion down-stream from the point of injection.

The Lone Star Producing Co. has practiced the injection of chemicals into wells in the Opelika field for more than a year. The initial treatment tried in the Opelika field involved the injection of soda ash solution into the well casing at a rate of 1.0 pounds of soda ash per million cubic feet of gas produced from the well. As these wells are produced through tubing only, the soda ash solution injected into the casing trickled down the casing to the producing formation and left the well through the produced gas stream in the tubing. This method of chemical treatment reduced the rate of corrosion very materially as indicated by chemical tests and also by visual examination of surface fittings.

However, a calcium carbonate scale was deposited in the tubing perforation or in the tubing itself that eventually built up to sufficient thickness to act as an effective bottom hold choke. This scale was easily removed by treatment with 4 barrels of acid per well but reformed at such a rate that acidization was required again in approximately 30 days. In an attempt to reduce the rate of deposition of this calcium scale, the concentration of soda ash was reduced to about 0.10 pounds per million cubic feet of gas produced. An equal amount of sodium hexametaphosphate was added to the solution in an attempt to avoid calcium deposition and also possibly to serve as an inhibitor. An organic chromium compound was also added to the treating solution in the amount of approximately 0.05 pounds per million cubic feet of gas produced to act as an additional corrosion inhibitor.

This solution did not appear to cause deposition of sufficient calcium carbonate scale to require frequent acidization. However, this solution was far less effective in reducing the rate of corrosion than was the more concentrated soda ash solution used originally. The organic chromium compound has recently been replaced in this solution by sodium dichromate with 0.20 pounds of sodium dichromate used per million cubic feet of gas produced. The sodium dichromate appears to be much more effective in this service than the organic chromium compound first used.

The Lone Star Producing Co. has used various other chemicals and inhibitors for short lengths of time on various wells. Aqueous ammonia was injected into one well and reduced corrosion satisfactorily but caused calcium carbonate deposition. An organic corrosion inhibitor was injected into another well for a period of several months with some apparent reduction in the rate of corrosion of the surface fittings. However, traces of sludge in this inhibitor interfered seriously with operation of the pump used for injection, so further work on this inhibitor was abandoned. Sodium silicate was injected into one wellhead at a rate of 0.8 pounds of silicate per million cubic feet of gas. A heavy deposit of silica was found in the wellhead at the point of injection after three weeks of operation, so use of this chemical was abandoned even though chemical tests indicated excellent corrosion control.

There are a wide variety of inhibitors that might be useful in this service. Additional field tests are planned on some of these inhibitors.

Protective Coatings Tried

Protective coatings have not been tried extensively in field service. The Lone Star Producing Co. recently had a section of a Christmas tree coated internally with a synthetic plastic lining that was baked on. This coating was inspected after six weeks of service and appeared to be in perfect condition.

Protective films are subject to failure for one reason or another and it is possible that corrosive attack may be concentrated at the points of failure. Satisfactory alloys are not subject to this objection. Therefore, a study of the use of low-cost alloys is indicated. This study would necessarily be slow as possible alloys should be exposed to actual operating conditions for a sufficient length of time to determine whether or not they are slowly corroded in service. Such alloys are extremely difficult to obtain under existing conditions and service tests of at least 12 months would be required to indicate the relative values of any alloys that might prove satisfactory.

In this connectoin, a 2-inch flanged tee which was recently removed from a well in the Grapeland, Texas field was found to be practically free of corrosion, whereas the two valves bolted directly to the tee were badly corroded. Investigation disclosed that the metal in this particular tee contained approximately 0.5% chromium and 1.5% nickel. If an inexpensive alloy generally resistant to this type of corrosion could be found, its wide use would be indicated.

Any conclusions based on observations of the behavior of alloys are necessarily subject to question if the exposed surface of the alloy is small, and if the alloy is in electrical contact with ordinary steel pipe or fittings, due to the likelihood of setting up galvanic cells under these conditions in which the alloy could become cathodic, and might be protected at the expense of the adjacent steel equipment. Observations of gate valves have shown that brass guides in these valves and hard-surfaced disks in these valves have not been corroded, whereas the steel parts of these valves have been badly corroded. Stainless-steel sampling tubes have been unaffected by this corrosion, whereas steel sampling tubes have failed after two years of service. Orifice plates of stainless steel have remained free of any signs of corrosion, while the steel meter runs have been badly corroded.

The successful injection of chemicals into the flow stream below the surface fittings is almost impossible for mechanical reasons in a dually completed well or in a well in which the tubing is packed off from the casing. In such wells the use of satisfactory alloys or of satisfactory protective films on subsurface equipment appears to be the only practicable means of combating internal corrosion due to the mechanical difficulties of introducing any possible method of chemical or electrical protection into the flowing stream below the surface fittings when the well is in operation. Continuous chemical treatment of any well involves an appreciable expenditure for operation of the injecting equipment, and requires constant and careful supervision, again emphasizing the desirability of alloys.

Future Work

An intelligent attack on this problem would require determination of the causes of this corrosion. These causes are not definitely known at present. Complete information regarding the chemical nature of the produced fluids and the geologic and physical conditions of production should be of material assistance in attempting to determine causes of this corrosion. It is, of course, obvious that determination of the causes of this corrosion would be of tremendous value to the operator who drills in a new high-pressure field and must specify the type of equipment to be installed in this field. A knowledge of the cause or causes of corrosion could also be of material benefit in planning ways and means of eliminating or minimizing this corrosion.

Acknowledgment

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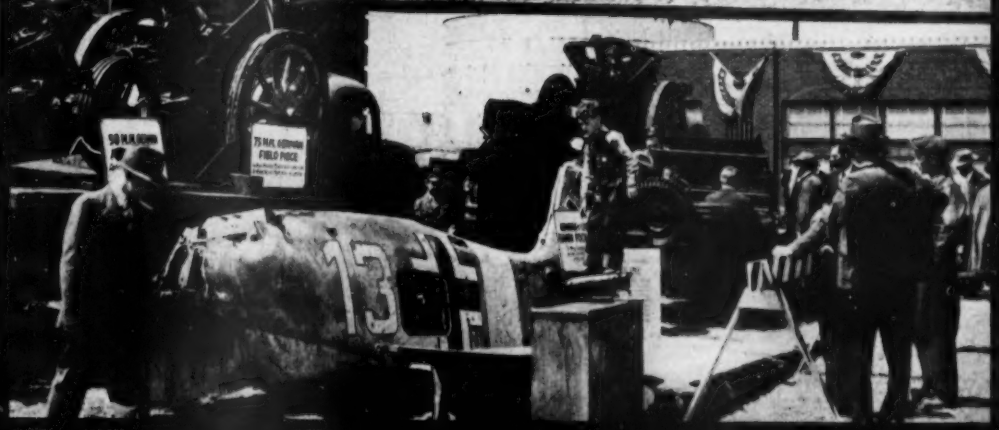
Battle Front Takes in the Wood River Refinery

For one day, when its new aviation gasoline plant was formally dedicated, Wood River refinery of Shell Oil Co. Inc. was part of the fighting front. Demonstrations of smoke screening by regular Army troops, planes streaking high overhead, exhibits of captured enemy equipment and displays of the guns our own troops use, gave a vivid impression of warfare today.

Several thousand refinery workers and their families gathered in a huge pavilion to hear officers tell the part 100-octane gasoline is playing in winning the war. Under Secretary of War Patterson, Mrs. James Doolittle, wife of the famous flier, and Alexander Fraser, Shell's president, buried a time capsule containing a sample of the first 100-octane gasoline shipped to the U.S. Army, 10 years before from a Shell refinery.

Objective of the company management in the ceremonies was to impress on plant workers how vital to the war effort is their task in maintaining full production of aviation gasoline.



THERMODYNAMICS OF SOLUTIONS—

Ideal Systems at High Pressures

(Article 4 in a Series)

By B. W. Gamson and K. M. Watson**

An ideal system is defined as a mixture of components which at low temperatures tend to form ideal liquid solutions.

Based on an extension of the pseudo critical concept of Kay, methods are developed for calculating densities and enthalpies in both the liquid and gaseous states of complex solutions which constitute ideal systems. These methods are applicable where ideal solutions are not formed, as when a gas is present at a temperature above its critical in a liquid solution. The basic methods of calculation are extended to derive general expressions for partial molal volumes and enthalpies which are useful for vapor-liquid equilibrium calculations.

WITHIN the past decade, numerous process developments have been introduced in the petroleum and chemical industries which involve operations at pressures and temperatures where the laws of ideal solutions are not applicable. Various procedures have been proposed [2, 6, 7, 9, 12, 20] for estimating densities, enthalpies and vaporization equilibrium relationships for complex mixtures at these conditions.

This investigation was undertaken in an attempt to improve and extend such correlations for the prediction of both the thermodynamic properties of mixtures as a whole and the partial molal properties of their components. By a modified application of the theorem of corresponding states, it was found possible to correlate properties of solutions with a degree of accuracy sufficient for many engineering purposes.

Ideal and Non-Ideal Systems

When two or more chemically pure substances are mixed at constant temperature and pressure with no change in volume or enthalpy, the resulting mixture is termed an ideal solution. It may be demonstrated that this behavior is thermodynamically required by the general definition that an ideal solution is one in which the fugacity of each component is proportional to its mole fraction.

Nearly ideal liquid solutions are formed by closely related homologs of a series of organic compounds such as heptane and octane, or benzene and toluene at atmospheric temperatures. However, if the temperature is increased and the liquids are maintained at saturation, the deviations from ideal behavior increase. Finally, conditions are reached at which the more volatile component is above its critical temperature and large deviations from additivity of volumes result, depending upon the pressure under which the mixture is confined.

Thus, even adjacent homologs form ideal liquid solutions only at low temperatures corresponding to low vapor pressures for both the solution and the individual components. The greater the differences between the properties of the homologs, the lower the temperatures at which ideal solutions occur. It is proposed that mixtures exhibiting such properties be termed *ideal systems.*

An ideal system may be defined as a group of chemically similar components which tend to form ideal liquid solutions at low temperatures where the saturated vapor of each component behaves as an ideal gas. Many solutions, particularly those involving highly polar compounds, deviate widely in the liquid state from the laws of ideal systems at all temperatures. These are characterized as non-ideal systems. For example, chemically dissimilar materials, such as alcohol and benzene, never form ideal liquid solutions.

Chemical homologs generally behave as approximately ideal systems but do not form ideal solutions at all conditions. Thus, solutions of liquid ethane and heptane at atmospheric temperatures depart widely from ideal behavior but at lower temperatures approach ideality. Many somewhat dissimilar materials but of low polarity may be treated as ideal systems with accuracy satisfactory for many purposes. The greatest deviations from the behavior of the ideal system are encountered with highly polar compounds such as water, ammonia, the lower alcohols, and ketones.

Non-ideal solutions have properties which are either greater or less than the sum of the properties of the pure components and ordinarily can be determined only from direct experimental data. The deviations from ideal behavior which are exhibited by ideal liquid systems may be designated as *deviations due to differences in molecular size.* Non-ideal systems show this same type of deviation and in addition the *deviations due to differences in molecular type* or chemical dissimilarity which characterize the behavior of such systems at low temperatures.

In general, it is observed that deviations from ideal behavior which are due to chemical dissimilarity decrease with increased temperature, whereas deviations due to differences in molecular size increase as the temperature is increased. The opposite temperature effects result in a temperature range of minimum deviation from the laws of ideal solutions for some non-ideal systems. At low temperatures large deviations due to chemical dissimilarity are encountered which are reduced as the temperature is increased. Still further increase in temperature leads to important deviations due to dissimilarity in size. It is probable that in this higher temperature range where deviations due to chemical dissimilarity are small in comparison to those due to differences in molecular size, some of the generalizations developed in the following paragraphs for ideal systems may be applicable without serious errors to non-ideal systems.

The variation in the properties of liquid systems with respect to temperature is in sharp contrast with that observed for gaseous systems. For the latter, deviations from ideal solutions decrease as the temperature is increased because of the larger distances through which the attractive forces must act. Maximum deviations are introduced in the region of the critical point because of the approach to condensed liquid state where the effect of dissimilarity in size becomes pronounced.

Densities of Gaseous Solutions

Numerous methods have been suggested for calculating densities of gaseous mixtures. The simplest of these are the familiar laws of Dalton and Amagat. Unfortunately, both lead to very large errors when applied to gaseous mixtures at high pressures.

Beattie[1] proposed methods for evaluating the equation constants of the Beattie-Bridgman equation of state for a gaseous mixture from the constants for the pure components. This method can only be used when the Beattie-Bridgman constants for the individual components are available; furthermore, it is only valid for volumes greater than the critical. Gilliland [5] suggested a modification of Beattie's methods with the simplifying

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assumption that the isometric lines when plotted on the P-T plane are straight lines.

Kay [10] advanced the concept of treating a gaseous mixture as if it were a pure component having a critical temperature and pressure equal to what he termed the pseudo critical temperature and pressure of the mixture. By proper selection of the pseudo critical temperature and pressure it was found that compressibility data for mixtures were in good agreement with generalized relationships [2, 12, 22] between compressibility factors, pv/RT, and reduced temperature and pressure. The mean compressibility factor of a mixture is obtained from such a generalized compressibility factor chart at the pseudo reduced temperature and pressure of the mixture.

Kay found that the pseudo critical temperature and pressure are approximately the molal averages of the corresponding values of the pure components. On this basis,

$$T_c' = (T_c)_A y_A + (T_c)_B y_B + (T_c)_C y_C + \ldots$$

$$= \Sigma T_{ci} y_i \quad \ldots\ldots (1)$$

$$p_c' = (p_c)_A y_A + (p_c)_B y_B + (p_c)_C y_C + \ldots$$

$$= \Sigma p_{ci} y_i \quad \ldots\ldots (2)$$

From pseudo critical constants calculated in this manner, pseudo compressibility factors z' are taken as corresponding to the pseudo reduced temperature and pressure, T_r' and p_r'. Then for the mixture,

$$v = \frac{z' n RT}{p} \quad \ldots\ldots (3)$$

It must be emphasized that Equations 1 and 2 are only approximations and do not yield pseudo critical properties which result in the best possible correlations for mixtures of components of widely different boiling points. Kay and later Smith and Watson [19] proposed more accurate relationships for hydrocarbon mixtures but failed to extend these methods to the general case.

Densities or volumes of gaseous mixtures calculated from Equations 1, 2 and 3 are sufficiently accurate for most engineering purposes, and it is believed to be the best general method available. However, serious errors result in some cases and it is hoped that improved correlations may be found. The errors are attributable both to the inaccuracies of Equations 1 and 2 for estimating the pseudo critical properties and to the deviations from the generalized relationship between compressibility factor z and reduced conditions, T_r and p_r.

Densities of Liquid Solutions

Generalized methods for computing the densities of liquid solutions have not been available except for specific systems. Sage and co-workers [14] advanced a method using partial molal volumes for computing the densities of hydrocarbon liquids. Their data cover a limited composition range and do not include low molecular weight mixtures. Standing and Katz [20] proposed calculating densities of liquid hydrocarbon mixtures by assuming additive volumes for all constituents less volatile than ethane and using apparent densities for methane and ethane as a function of their composition in liquid solutions at 60°F and one atmosphere pressure. Hanson and coworkers [6] applied the method of Standing and Katz to the calculation of liquid densities of volatile hydrocarbon mixtures

Watson [21] suggested a method for calculating the liquid densities of pure compounds from a generalized plot of an empirical expansion factor, ω, which is a function only of reduced temperature and pressure. The density ρ or volume v at any specified conditions are given by Equation 4 in terms of the density or volume at some reference condition designated by the subscript (1) and the corresponding values of the expansion factor.

$$\rho = (\rho_1/\omega_1)\omega; \quad v = (v_1\omega_1)/\omega \quad \ldots\ldots (4)$$

Equation 4 can be used for calculating densities when one liquid density value is available to establish (ρ_1/ω_1) or $(v_1\omega_1)$. Methods of estimating ρ_1/ω_1 for organic compounds were developed by the authors [4] together with a table of values for the paraffin hydrocarbons.

The empirical expansion factor correlation may be applied to solutions in ideal systems through the use of the pseudo critical concept. If components $A, B, C \ldots$ may be considered as an ideal system, at some low temperature T° they will form an ideal solution in which the volumes of the components are additive. Thus

$$V^* = V_A^* + V_B^* + \ldots = \Sigma V_i^*$$

$$= \frac{m_A}{\rho_A^*} + \frac{m_B}{\rho_B^*} + \ldots \quad \ldots\ldots (5)$$

Combining with Equation 4,

$$V^* = \frac{\omega_{A1} m_A}{\rho_{A1}\omega_A^*} + \frac{\omega_{B1} m_B}{\rho_{B1}\omega_B^*} + \ldots$$

$$= \Sigma \frac{\omega_i m_i}{\rho_i \omega_i^*} \quad \ldots\ldots (6)$$

The value of ω_{A1} is determined from the expansion factor chart by expressing T_{A1} and P_{A1} in reduced conditions based on the critical properties of component A. It is evident from consideration of the expansion factor chart [21] that as T° is decreased $\omega_A^\circ, \omega_B^\circ, \ldots$ approach equality. It is reasonable to assume that if the relationship were extrapolated to the absolute zero the values of ω for all compounds would become equal to ω_o. Taking T° as the absolute zero,

$$V_o = \frac{1}{\omega_o}\left(\frac{\omega_{A1}}{\rho_{A1}} m_A + \frac{\omega_{B1}}{\rho_{B1}} m_B + \ldots\right)$$

$$= \frac{1}{\omega_o} \Sigma \left(\frac{\omega_1}{\rho_1}\right)_i m_i$$

$$= \frac{1}{\omega_o} \Sigma (v_1\omega_1)_i n_i \quad \ldots\ldots (7)$$

The volume V of the solution at any temperature and pressure is obtained by applying Equation 4 to the entire mixture and combining it with Equation 7. Thus

$$V' = \frac{V_o\omega_o}{\omega'} = \frac{1}{\omega'} \Sigma \left(\frac{\omega_1}{\rho_1}\right)_i m_i \quad \ldots\ldots (8)$$

where V' is the volume of the liquid solution of mass Σm_i at temperature T and pressure p. Similarly, Equation 8 may be written in terms of moles and molal volumes. Accordingly,

$$V' = \frac{1}{\omega'} \Sigma (v_1\omega_1)_i n_i = \frac{(v_1\omega_1)'}{\omega'} \Sigma n_i \quad \ldots (9)$$

This expression defines $(v_1\omega_1)'$ of the mixture as equal to the molal average of the values of $(v_1\omega_1)_i$ of the components comprising the mixture. Since the critical volume is found to be equal to $(v_1\omega_1)/0.044$, this is equivalent to assuming that the pseudo critical volume of the mixture is equal to the molal average of the critical volumes of the pure components.

The expansion factor, ω', of the solution is derived from the generalized expansion factor chart by expressing the temperature and pressure in pseudo reduced units based on the pseudo-critical properties of the mixture as calculated from Equations 1 and 2. By means of Equation 8 or 9 it is possible to calculate the volume of an ideal liquid system at any temperature and pressure within the range of the expansion factor chart, even though some of the components may be above their critical temperatures. Great care must be exercised that this equation is applied only to the liquid state. Where vaporization occurs, the volumes of the liquid and vapor phases must be considered separately.

Table I compares liquid densities calculated from Equations 8 and 9 with experimental data from the indicated sources. The agreement is reasonably good, with deviations usually less than 3%. A similar order of agreement was found with the unpublished measurements of Hanson, Kuist and Brown[6] on the densities of light hydrocarbon mixtures containing large proportions of methane.

Enthalpies of Gaseous Solutions

Where an ideal solution is formed, the enthalpy of the solution is equal to the sum of the enthalpies of the components at the existing temperature and pressure. In the general case of a non-ideal solution in either an ideal or non-ideal

TABLE I—Densities of Liquid Mixtures

	T_c—°K	P_c—atm	$(v_{1\omega_1})$	Composition of Mixture in Mole Fractions 1	2	3	4
CH_4	190.7	45.8	4.356	0.2848	0.2848	0.4489	0.4489
Cyclo-hexane C_6H_{12}	554.3	40.4	13.80			0.5511	0.5511
C_6H_6	561.8	47.7	11.65	0.7152	0.7152		
Temp, °F.				37.8	104.4	37.8	104.4
Pressure, psi				2500	3000	3000	3000
T_r'				0.682	0.828	0.795	0.965
p_r'				3.60	4.32	4.75	4.75
$(v_{1\omega_1})'$				9.57	9.57	9.56	9.56
ω'				0.1201	0.1093	0.1126	0.0980
ρ_{calc} (Eq. 9), gm/cc				0.759	0.691	0.631	0.549
ρ_{exp}, gm/cc				0.771	0.700	0.634	0.557
% error				—1.6	—1.3	—0.5	—1.4
Citation				(17)	(17)	(17)	(17)

system, a heat of mixing is involved in the formation of the solution. The magnitude of the heat of mixing is a measure of the extent of the deviation from ideal behavior.

Under non-ideal conditions, the enthalpy of a gaseous mixture is best determined by first obtaining its enthalpy in the ideal gaseous state corresponding to zero pressure at the existing temperature and applying a correction for the isothermal effect of pressure on the enthalpy of the entire mixture. It is a corollary of Kay's pseudo critical concept that the change with pressure of the enthalpy of a mixture is the same as that of a pure compound whose critical properties are equal to the pseudo critical properties of the mixture. On this basis, generalized charts[22, 23] relating $(H^\circ - H)$ to p_r and T_r may be applied to mixtures by use of pseudo reduced conditions.

This procedure is straightforward where only the gaseous state is involved. The enthalpy of the mixture at zero pressure is obtained as the sum of the enthalpies of the components at the existing temperature and zero pressure. The pseudo reduced conditions of the mixture are then calculated, and the corresponding value of the enthalpy difference $(H^\circ - H)$ between the ideal and actual states determined directly from Fig. 1 for the entire mixture. Fig. 1 is a modification of the chart developed by Watson and Smith[22] which was prepared by taking into account the improved data calculated by Edmister[3] and York and Weber[23] and extended to low reduced temperatures by the Joule-Thomson data on water[8].

Enthalpies of Liquid Solutions

In dealing with solutions of liquids in an ideal system under such conditions that no component is at a reduced temperature above 0.9, it is generally satisfactory to assume that the enthalpy of the mixture is equal to the sum of the enthalpies of the components at the temperature and pressure of the mixture. For non-ideal systems, the heat of mixing must be added.

If some components of the mixture are at reduced temperatures above 0.9, a more nearly accurate procedure is to calculate the enthalpy of the liquid from the enthalpy of the ideal gas mixture at the existing temperature. It is assumed that the liquid is formed by compressing the gas to the pseudo vapor pressure of the mixture which may be considered as the vapor pressure of the equivalent pure compound whose critical properties, liquid density and heat of vaporization are equal to the corresponding pseudo properties of the mixture. Condensation to the liquid state is considered as occurring at this constant pressure accompanied by what may be termed pseudo-heat of condensation, $-\Lambda'$. The liquid is then compressed to the pressure of the mixture. Actually, of course, condensation occurs over a range of pressures.

In view of the other approximations involved, it is ordinarily satisfactry to assume for the calculation of liquid enthalpies, that the pseudo-reduced vapor pressure at which condensation of the mixture is assumed to occur is a unique function of pseudo-reduced temperature. As pointed out by the authors[4], this assumption is not accurate and should not be used for other purposes, but it leads to little error in calculating enthalpies.

At low temperatures where the saturated vapor of each component behaves as an ideal gas and the enthalpy of the vapors is independent of pressure, the heat of vaporization of a mixture constituting an ideal system at a temperature T is equal to the sum of the heats of vaporization of the individual components at this same temperature. Thus, the pseudo heat of vaporization of such a mixture may be estimated by assuming that at the absolute zero temperature the heats of vaporization are additive. The following equation[21] accurately represents the effect of temperature on the heat of vaporization of many polar and non-polar compounds:

$$\Lambda = \Lambda_1 \left(\frac{1-T_r}{1-T_{r1}} \right)^{.38} = \Lambda_o (1-T_r)^{.38} \quad (10)$$

where Λ_o is the latent heat of vaporization at the absolue zero and is equal to

$$\frac{\Lambda_1}{(1-T_{r1})^{.38}}$$

The value of the pseudo heat of vaporization of the mixture at the absolute zero is taken as the sum of the heats of vaporization of the components at the absolute zero as calculated from Equation 10. This value of Λ_o' is then corrected to any desired finite pseudo reduced temperature by Equation 10. Thus for a mixture of n_A, n_B, . . . moles of components A, B, . . . ,

$$\Lambda' = (1-T_r')^{.38}(n_A\lambda_{Ao} + n_B\lambda_{Bo} + \ldots)$$

$$= (1-T_r')^{.38}\Sigma n_i\lambda_{io} \quad \ldots\ldots\ldots\ldots (11)$$

The difference between the enthalpies of a liquid mixture at two different pressures under isothermal conditions may be obtained by application of the pseudo critical concept to the relationship developed by Watson[21] for the isothermal difference in enthalpy between a liquid at its critical pressure and any other pressure p. Thus,

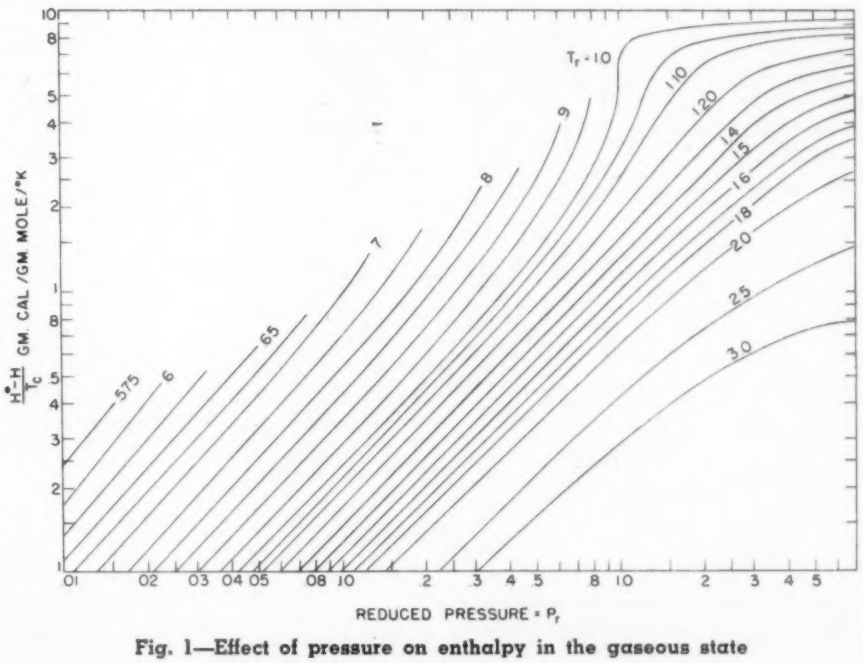

Fig. 1—Effect of pressure on enthalpy in the gaseous state

$$\frac{J}{p_c(v_1\omega_1)}(H_{cp}-H)_T=\psi \quad \ldots\ldots\ldots (12)$$

where ψ is a graphically expressed function of T_r and p_r derived from the expansion factor chart. Extension of these generalized liquid state charts to liquid mixtures through the use of the pseudo critical properties is justified by the results obtained in the calculation of densities of liquid mixtures. Thus the enthalpy, H_l', of the liquid mixture comprising n_t moles at temperature T and pressure p is

$$H_l'=H^*-n_tT_c'\left(\frac{H^*-H_s}{T_c'}\right)-\Lambda'+$$

$$n_tp_c'(v_1\omega_1)'(\psi_s'-\psi_l') \quad \ldots\ldots\ldots (13)$$

where H° = enthalpy of the mixture as an ideal gas at temperature T

$(H^\circ-H_s)/T_c'$ = value from Fig. 2 corresponding to the pseudo reduced temperature of the mixture

Λ' = pseudo heat of vaporization at temperature T

ψ_s' = value from Fig. 2 corresponding to the pseudo reduced temperature of the mixture

ψ_l' = value of ψ from the generalized chart[21], corresponding to the pseudo reduced conditions of the solution

In Fig. 2 are plotted values of $[(H^\circ-H_s)/T_c']$ and ψ_s' as functions of reduced temperature. These relationships are based on the assumption of a universal reduced vapor pressure curve corresponding approximately to that of iso-pentane. The values used in preparing Fig. 2 are summarized in Table II.

As previously pointed out, it is possible for liquids to exist at temperatures above the pseudo critical temperature of the mixture. Where only a single phase is present, such liquids may be treated as a highly compressed gas to which the enthalpy-pressure correction given by Fig. 1 is applicable. The enthalpy of the liquid is then

$$H_l=H^*-n_tT_c'\left(\frac{H^*-H}{T_c'}\right);$$

$$T_r'\geqq 1.0 \quad \ldots\ldots\ldots (14)$$

These equations are applicable only to single phase conditions. Where two phases exist, the enthalpy of each must be considered separately.

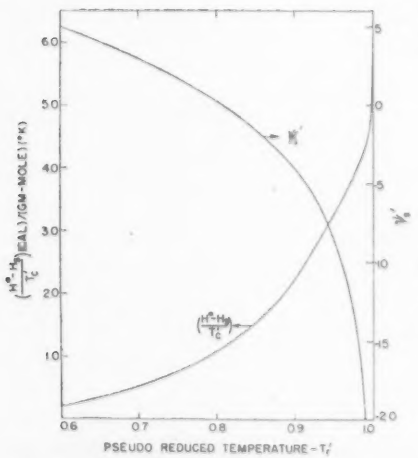

Fig. 2—Enthalpy corrections corresponding to average reduced vapor pressure relationship

Partial Molal Volumes in Gaseous Solutions

It is frequently desirable to calculate the partial thermodynamic behavior of each of the components comprising a system. Such relations are essential for the prediction of vapor-liquid equilibria in heterogeneous systems.

The partial value of any extensive property for any component in an ideal solution is identical with the respective value for the pure component. Where non-ideal solutions are formed the partial properties of a component vary with the composition of the solution and the natures of the other components. From the methods proposed for calculating the total volumes, it is possible to derive generalized expressions for the partial volumetric behavior of all constituents in gaseous solutions and in liquid solutions which constitute ideal systems.

The total volume of a gaseous system may be obtained from Equation 3 as

$$V=\frac{z'RT}{p}(n_A+n_B+\ldots)$$

$$=\frac{z'RT}{p}\Sigma n_i \quad \ldots\ldots\ldots (15)$$

where z' is a function of pseudo reduced temperature and pressure T_r' and p_r' which is determined from the generalized compressibility factor chart for pure compounds[22]. The pseudo-reduced temperature and pressure may be expressed in terms of the composition of the mixture in accordance with Equations 1 and 2. Thus,

$$T_r'=\frac{T}{T_c'}=\frac{T\Sigma n_i}{\Sigma n_iT_{ci}} \quad \ldots\ldots\ldots (16)$$

$$p_r'=\frac{p}{p_c'}=\frac{p\Sigma n_i}{\Sigma n_ip_{ci}} \quad \ldots\ldots\ldots (17)$$

The partial molal volume of component i in a phase composed of components $A, B \ldots$, is related to the total volume of the phase by

$$\overline{V}_i=\left(\frac{\partial V}{\partial n_i}\right)_{T_{pn}n_An_B\ldots}$$

$$=\left(\frac{\partial V}{\partial n_i}\right)_{T_{pn}} \quad \ldots\ldots\ldots (18)$$

TABLE II

Values of $(H^\circ-H_s)/T_c'$ and ψ_s'

Pseudo-reduced Temperature, T_r'	$\left(\frac{H^\circ-H_s}{T_c'}\right)$ [a]	ψ_s'
0.6	0.20	5
0.65	0.34	4
0.70	0.52	3
0.75	0.75	1.7
0.80	1.08	0.3
0.85	1.53	— 1.6
0.90	2.21	— 4
0.92	2.63	— 5.4
0.94	3.06	— 7.2
0.95	3.30	— 8.5
0.96	3.49	—10
0.97	3.70	—11.7
0.98	3.96	—14.2
0.99	4.26	—20
0.995	4.50	.....
1.0	5.5	0

a)—cal/(g-mole) (°K).

where n represents the number of moles of all components other than component i. Equation 15 may be differentiated with respect to the number of moles of component i in accordance with Equation 18. Thus,

$$\overline{V}_i=\frac{RT}{p}\left[z'+\left(\frac{\partial z'}{\partial n_i}\right)_{T_{pn}}\Sigma n_i\right] \quad (19)$$

Since z' is a function only of p_r' and T_r', the differential term of Equation 19 may be written as,

$$\left(\frac{\partial z'}{\partial n_i}\right)_{T_{pn}}=\left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'}\left(\frac{\partial T_r'}{\partial n_i}\right)_n+$$

$$\left(\frac{\partial z'}{\partial p_r'}\right)_{T_r'}\left(\frac{\partial p_r'}{\partial n_i}\right)_n \quad \ldots\ldots\ldots (20)$$

Differentiating Equation 16,

$$\left(\frac{\partial T_r'}{\partial n_i}\right)_n=\left(\frac{T_r'}{\Sigma n_i}\right)\left(1-\frac{T_{ci}}{T_c'}\right) \quad (21)$$

Similarly, from Equation 17

$$\left(\frac{\partial p_r'}{\partial n_i}\right)_n=\left(\frac{p_r'}{\Sigma n_i}\right)\left(1-\frac{p_{ci}}{p_c'}\right) \quad (22)$$

It was pointed out that calculations of the pseudo-critical constants by Equations 1 and 2 are not exact, although they are satisfactory for estimating the total properties of mixtures. It is well known that small errors in the total property are magnified manyfold upon differentiation. Accordingly, it was necessary to include additional terms in Equations 21 and 22 to correct for the inexactness of the original definitions. The corrections are in the form of multiplying factors which are approximately equal to the ratio of the critical property of the component to the pseudo critical property of the mixture all raised to an empirically determined exponent. This exponent was evaluated as approximately 0.6 from experimentally determined par-

TABLE III—Partial Molal Volumes of Gaseous Solutions

Methane—*n*-Butane[12]

Mole fr C_1	Temp. °F.	Pressure lb./sq. in.	Exp. $\overline{v}_i$, ft.³/lb.		Calc. $\overline{v}_i$, ft.³/lb.	
			C_1	C_4	C_1	C_4
0.2870	160	100	4.15	0.98	4.41	1.02
	220	300	1.62	.262	1.70	.264
	220	500	1.138	.118	1.122	.121
0.706	130	300	1.31	.195	1.32	.216
	190	500	.864	.108	.880	.130
	190	1500	.292	—.0095	.278	—.0102
	190	3000	.123	.0118	.129	.0110
0.9355	70	500	.664	.070	.674	.065
0.9702	70	500	.663	.077	.664	.074
	70	200	.143	—.0267	.139	—.0316
	160	500	.801	.129	.805	.150
	160	3000	.126	0	.124	—.004
	250	500	.933	.164	.930	.208
	250	3000	.154	.0128	.156	.0143

tial molal volumes in both liquid and gaseous mixtures[13, 15] and from vapor-liquid equilibrium data[11]. With these corrections, Equations 21 and 22 become,

$$\left(\frac{\partial T_r'}{\partial n_i}\right)_n = \frac{T_r'}{\Sigma n_i}\left(1-\frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6} \quad \ldots(23)$$

$$\left(\frac{\partial p_r'}{\partial n_i}\right)_n = \frac{p_r'}{\Sigma n_i}\left(1-\frac{p_{ci}}{p_c'}\right)\left(\frac{p_{ci}}{p_c'}\right)^{.6} \quad \ldots(24)$$

Combining Equations 19, 20, 23 and 24 results in a universal expression for the partial molal volume of any component comprising a gaseous mixture.

$$\overline{V}_i = \frac{RT}{p}\left[z' + T_r'\left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'} \times \left(1-\frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6} + p_r'\left(\frac{\partial z'}{\partial p_r'}\right)_{T_r'}\left(1-\frac{p_{ci}}{p_c'}\right) \times \left(\frac{p_{ci}}{p_c'}\right)^{.6}\right] \quad \ldots(25)$$

Table III compares gaseous partial molal volumes calculated from Equation 25 with experimental values. The errors in most instances are within about ±15%. These errors may be attributed both to the inaccuracy of the fundamental relationship of z to p_r and T_r and to the lack of a satisfactory relationship for calculating pseudo critical properties.

Partial Volumes in Liquid Solutions

Volumes of liquid mixtures in an ideal system are calculated from Equation 8 or 9. In a manner similar to that outlined for the gaseous state, it is possible to derive an expression for partial molal volumes of components in an ideal liquid system. Thus, differentiating Equation 8 with respect to component i,

$$\overline{V}_i = \frac{(v_1\omega_1)_i}{\omega'} + \left(\frac{\partial(1/\omega')}{\partial n_i}\right)_{Tpn} \Sigma n_i(v_1\omega_1)_i \quad \ldots(26)$$

Noting that

$$\partial(1/\omega) = -\frac{\partial\omega'}{(\omega')^2}$$

Equation 26 becomes

$$\overline{V}_i = \frac{(v_1\omega_1)_i}{\omega'} - \frac{1}{(\omega')^2}\left(\frac{\partial\omega'}{\partial n_i}\right)_{Tpn} \Sigma n_i(v_1\omega_1)_i \quad (27)$$

Since ω' is a universal function of the dependent variables T_r' and p_r', the total derivative is

$$d\omega' = \left(\frac{\partial\omega'}{\partial T_r'}\right)_{p_r'} dT_r' + \left(\frac{\partial\omega'}{\partial p_r'}\right)_{T_r'} dp_r' \quad \ldots(28)$$

Equation 28 may also be written,

$$\left(\frac{\partial\omega'}{\partial n_i}\right)_{Tpn} = \left(\frac{\partial\omega'}{\partial T_r'}\right)_{p_r'}\left(\frac{\partial T_r'}{\partial n_i}\right)_n + \left(\frac{\partial\omega'}{\partial p_r'}\right)_{T_r'}\left(\frac{\partial p_r'}{\partial n_i}\right)_n \quad \ldots(29)$$

Combining Equations 23, 24, 27, and 29, results in a universal expression for the partial molal volume of any component in a liquid mixture of an ideal system.

$$\overline{V}_i = \frac{(v_1\omega_1)_i}{\omega'} - \frac{(v_1\omega_1)'}{(\omega')^2} \times \left[T_r'\left(1-\frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6} \times \left(\frac{\partial\omega'}{\partial T_r'}\right)_{p_r'} + p_r'\left(1-\frac{p_{ci}}{p_c'}\right) \times \left(\frac{p_{ci}}{p_c'}\right)^{.6}\left(\frac{\partial\omega'}{\partial p_r'}\right)_{T_r'}\right] \quad \ldots(30)$$

The terms

$$\left(\frac{\partial\omega'}{\partial T_r'}\right)_{p_r'} \text{ and } \left(\frac{\partial\omega'}{\partial p_r'}\right)_{T_r'}$$

may be expressed as functions of T_r' and p_r' by differentiation of the expansion factor chart[21]. These relationships are plotted in Figs. 3 and 4.

Table IV compares liquid partial molal volumes calculated from Equation 30 with experimental values. Here also the errors in most instances are about ±10%.

Partial Molal Enthalpies

In the evaluation of generalized methods for the prediction of vapor-liquid equilibria, it is desirable to establish expressions for partial molal enthalpies. Methods analogous to those employed for deriving partial molal volumes of vapor and liquid solutions may be applied in the derivation of partial molal enthalpies.

Previously it was shown that the enthalpy of a gaseous solution may be calculated in a straightforward manner by first obtaining its enthalpy in the gaseous state at zero pressure and at the existing temperature and applying an isothermeral correction for the effect of pressure on the enthalpy of the entire mixture based upon its pseudo-critical properties.

Thus, the molal enthalpy H of the mixture is expressed by,

$$H = H^* - \frac{T}{T_r'}\left(\frac{H^*-H}{T_c'}\right) = H^* - T\theta' \quad \ldots(31)$$

where

$$H^* = \frac{\Sigma n_i H_i^*}{n_t}$$

$$\theta' = \frac{1}{T_r'}\left(\frac{H^*-H}{T_c'}\right)$$

The quantity θ' is readily obtained from Fig. 1. Differentiating Equation 31 with respect to the i'th component,

$$\bar{H}_i = \left(\frac{\partial H}{\partial n_i}\right)_{Tpn} = -T\theta' - T\left(\frac{\partial \theta'}{\partial n_i}\right)_{Tpn} \Sigma n_i + H_i^* \quad \ldots\ldots (32)$$

Since θ' is a single-valued function of pseudo reduced temperature and pressure

$$\left(\frac{\partial \theta'}{\partial n_i}\right)_{Tpn} = \left(\frac{\partial \theta'}{\partial T_r'}\right)_{p_r'} \left(\frac{\partial T_r'}{\partial n_i}\right)_n + \left(\frac{\partial \theta'}{\partial p_r'}\right)_{T_r'} \left(\frac{\partial p_r'}{\partial n_i}\right)_n \quad \ldots\ldots (33)$$

A universal expression for the partial molal enthalpy of any component in a gaseous mixture is obtained by combining Equations 23, 24, 32 and 33. Thus,

$$\bar{H}_i = H_i^* - T\theta' - T\left[\left(\frac{\partial \theta'}{\partial T_r'}\right)_{p_r'} \times T_r'\left(1 - \frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6} + \left(\frac{\partial \theta'}{\partial p_r'}\right)_{T_r'} \times p_r'\left(1 - \frac{p_{ci}}{p_c'}\right)\left(\frac{p_{ci}}{p_c'}\right)^{.6}\right] \quad \ldots\ldots (34)$$

Values of

$$\left(\frac{\partial \theta'}{\partial T_r'}\right)_{p_r'} \text{ and } \left(\frac{\partial \theta'}{\partial p_r'}\right)_{T_r'}$$

may be obtained from charts derived[21] from Fig. 1 relating

$$\left(\frac{\partial\left(\frac{H^*-H}{T_c}\right)}{\partial T_r}\right)_{p_r} \text{ and } \left(\frac{\partial\left(\frac{H^*-H}{T_c}\right)}{\partial p_r}\right)_{T_r}$$

to reduced temperature and pressure. Thus,

$$\left(\frac{\partial \theta'}{\partial T_r'}\right)_{p_r'} = -\frac{1}{(T_r')^2}\left(\frac{H^*-H}{T_c'}\right) + \frac{1}{T_r'}\left[\frac{\partial\left(\frac{H^*-H}{T_c'}\right)}{\partial T_r'}\right]_{p_r'} \quad \ldots\ldots (35)$$

$$\left(\frac{\partial \theta'}{\partial p_r'}\right)_{T_r'} = \frac{1}{T_r'}\left[\frac{\partial\left(\frac{H^*-H}{T_c'}\right)}{\partial p_r'}\right]_{T_r'} \quad \ldots\ldots (36)$$

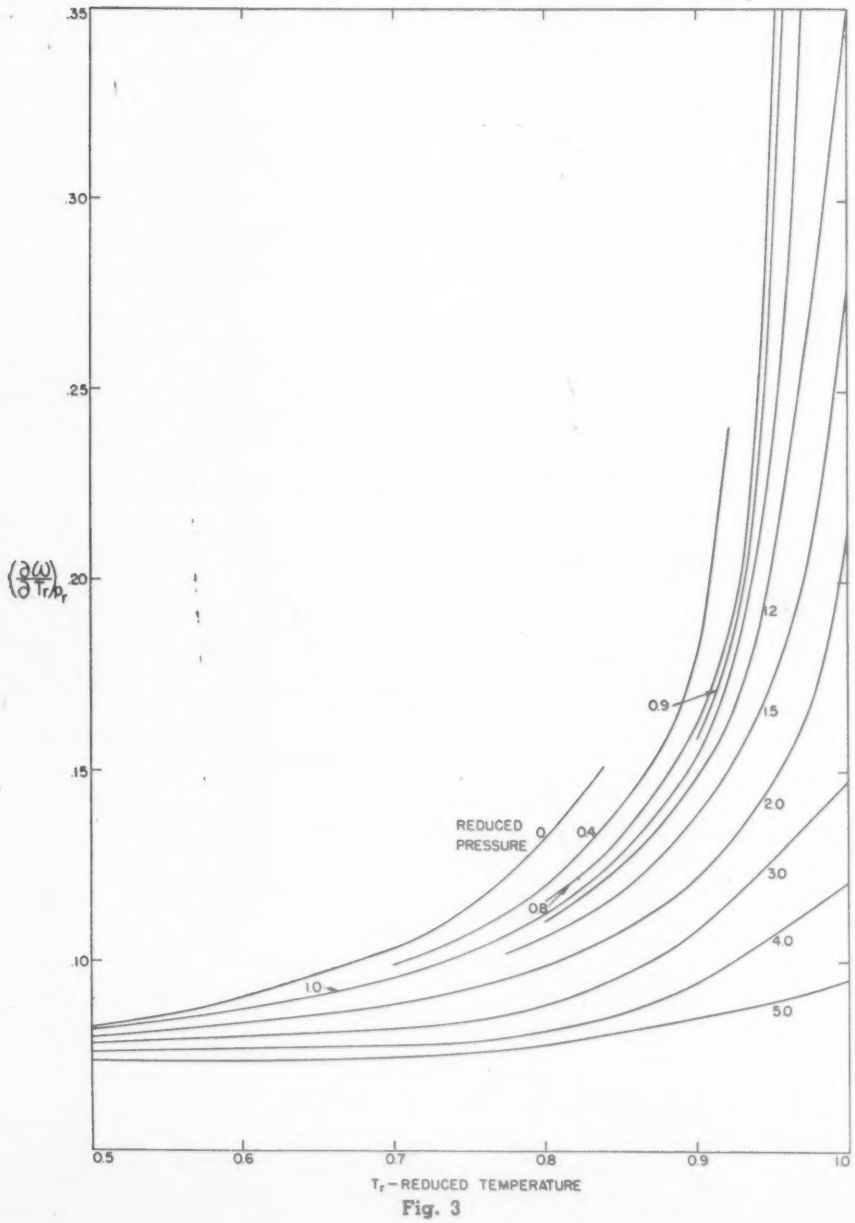

Fig. 3

In Table V are comparison of partial enthalpies calculated from Equation 34 with values based on direct experimental data. It will be noted that the agreement is not particularly good, with errors up to 100 Btu/lb. These discrepancies are probably for the most part due to the frequently noted errors inherent in the generalized application of Fig. 1.

Partial Enthalpies in Liquid Solutions

The enthalpy of a liquid solution comprising n_t moles is given by Equation 13. A generalized expression for the partial molal enthalpy of any component may be derived by differentiation of this equation by the same generalized method applied to the expressions for gaseous solutions. The equation consists of four terms which may be differentiated individually with respect to n_t. Thus,

$$\left(\frac{\partial H^*}{\partial n_i}\right)_{Tpn} = H_i^* \quad \ldots\ldots (37)$$

Since $(H^\circ - H_z)$ is assumed to be a unique function of pseudo reduced temperature, represented by Fig. 2, the derivative of the second term may be combined with Equation 23 and written as,

$$\left(\frac{\partial(H^*-H_s')}{\partial n_i}\right)_{Tpn}$$

$$= T_c'\left(\frac{H^*-H_s'}{T_c'}\right) +$$

$$(T_r')^2 T_c'\left(1-\frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6}\times$$

$$\left[\frac{\partial\left(\frac{H^*-H_s'}{T}\right)}{\partial T_r'}\right]_{Tpn} \quad \ldots\ldots\ldots\ldots (38)$$

The derivative of the third term is obtained from Equation 11 and in combination with Equation 23 may be written as

$$\left(\frac{\partial\Lambda'}{\partial n_i}\right)_{Tpn}$$

$$= (1-T_r')^{.38}\lambda_{i0} + .38\lambda_o'(1-T_r')^{-.62}\times$$

$$\left(\frac{T_{ci}}{T_c'}-1\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6} T_r' \quad \ldots\ldots (39)$$

TABLE IV

Partial Molal Volumes of Liquid Solutions
Methane—*n*-Butane System[12]

Mole fr C_1	Temp. °F.	Pressure lb./sq. in.	Exp. $\overline{V}$, ft.³/lb.		Calc. $\overline{V}$, ft.³/lb.	
			C_1	C_4	C_1	C_4
0	70	250	.0622	.0274	.0583	.0278
	70	1000	.0595	.0270	.0561	.0274
	70	3000	.0525	.0263	.0503	.0264
	160	250	.0915	.0307	.0794	.0310
	160	1000	.0803	.0298	.0711	.0304
	160	2500	.0650	.0286	.0617	.0288
	250	1000	.133	.0349	.111	.0346
	250	2500	.0808	.0322	.0804	.0318
.4755	100	1500	.1022	.0209	.1057	.0155
	100	3000	.0734	.0248	.0715	.0229
	70	1500	.0821	.0228	.0813	.0203
	70	3000	.0645	.0246	.0640	.0235
.2870	70	1000	.0680	.0265	.0667	.0262
	70	2000	.0617	.0264	.0600	.0261
	70	3000	.0522	.0259	.0558	.0259
	160	1500	.0968	.0281	.100	.0260
	160	3000	.0731	.0280	.0728	.0274

Methane—Decane[16]

Mole fr C_1	Temp. °F.	Pressure lb./sq. in.	Exp. $\overline{V}$, ft.³/lb.		Calc. $\overline{V}$, ft.³/lb.	
			C_1	C_{10}	C_1	C_{10}
0	70	500	.0495	.0218	.0523	.0218
0	70	2000	.0477	.0215	.0500	.0215
0	160	500	.0563	.0229	.0608	.0229
0	160	2000	.0531	.0226	.0604	.0226
0	250	500	.0632	.0244	.0720	.0245
0.496	70	2500	.0532	.0210	.0589	.0204
0.496	100	2500	.0572	.0214	.0627	.0208

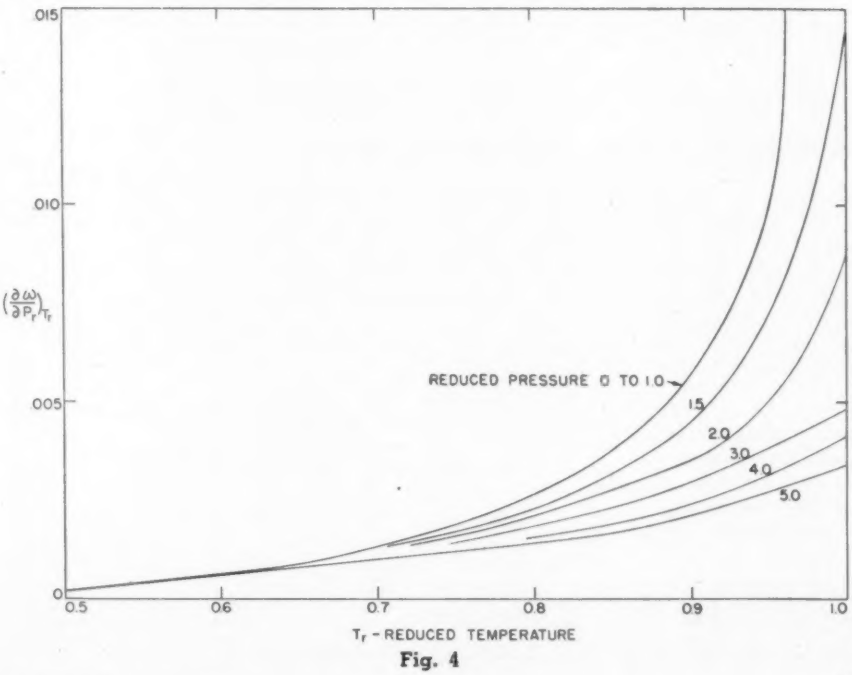

Fig. 4

The expression $p_c'(v_1\omega_1)'(\psi_1-\psi_s)'$ in Equation 13 represents the difference between the liquid enthalpy at the pseudo reduced vapor pressure and that at the pseudo reduced pressure of the mixture. Thus, the term $(\psi_1-\psi_s)'$ is a function of both pseudo reduced pressure and pseudo reduced temperature, although as indicated earlier, little error is introduced in taking ψ_s' as a single-valued function of pseudo-reduced temperature.

Accordingly,

$$H_s-H_l = p_c'(v_1\omega_1)'(\psi_1-\psi_s)'n_t \quad \ldots (40)$$

and the partial derivative of Equation 40 becomes

$$\left[\frac{\partial(H_s-H_l)}{\partial n_i}\right]_{Tpn}$$

$$= \left[p_c'(v_1\omega_1)_i + p_c'(v_1\omega_1)'\times\right.$$

$$\left.\left(\frac{p_{ci}}{p_c'}-1\right)\left(\frac{p_{ci}}{p_c'}\right)^{.6}\right]\times$$

$$(\psi_1'-\psi_s') + p_c'(v_1\omega_1)'\times$$

$$\left\{T_r'\left(1-\frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6}\times\right.$$

$$\left[\frac{\partial(\psi_1'-\psi_s')}{\partial T_r'}\right]_{p_r'} +$$

$$p_r'\left(1-\frac{p_{ci}}{p_c'}\right)\left(\frac{p_{ci}}{p_c'}\right)^{.6}\times$$

$$\left.\left[\frac{\partial(\psi_1'-\psi_s')}{\partial p_r'}\right]_{T_r'}\right\} \quad \ldots\ldots (41)$$

The partial molal enthalpy of any component in a liquid mixture comprising an ideal system is equal to the sum of equations 37, 38, 39 and 41. Experimental data are not available with which to compare values calculated from these equations. However, since relationships based on Fig. 1 do not play an important part in these equations it is believed probable that the errors in calculated partial molal enthalpies for the liquid state may be considerably less than those encountered for the gaseous state in Table V.

Utility of Methods

The methods presented for calculating the total volumes and enthalpies of solutions in ideal systems provide straightforward means for handling calculations involving these properties. In order to calculate the density of a liquid solution containing light components which are above their critical temperatures, it is not necessary to employ arbitrarily assigned liquid densities for these components. Similarly, enthalpies are directly calculated without concern over arbitrary

TABLE V

Partial Molal Enthalpies (Calculated from Eq. 34)
(Reference state: the ideal gascous component at 60°F.)
Methane—*n*-Butane[13]

Mole		Pressure	Exp. $\overline{H}_i$ Btu/lb		Calc. $\overline{H}_i$ Btu/lb	
%, C_1	Temp. °F.	lb./sq. in.	$\overline{H}_1$	$\overline{H}_4$	$\overline{H}_1$	$\overline{H}_4$
97.02	70	200	— 0.1	— 3.6	— 1.4	— 7.4
		500	— 8.7	—15.5	—11.7	—27.7
		1000	—23.5	—34.3	—28.5	— 64
		3000	—68.8	—77.0	—77.7	— 158
	250	500	+99.1	67.6	96.9	61.7
		1500	83.9	31.6	81.1	27.3
		3000	64.7	— 7.7	66.0	— 8.9
84.47	130	500	31.9	— 3.2	26.2	— 4.5
		1500	8.6	—50.1	9.4	—77.7
		3000	—31.1	—69.8	—22.9	— 126
	250	500	104.9	55.4	97.8	58.1
		1500	95.3	8.0	88.2	14.0
		3000	77.0	—32.6	68.9	—32.8

heats of solution or vaporization of light components. Such calculations are of particular importance in establishing energy balances in high pressure fractionating columns where large quantities of light gases are present.

The expressions for partial molal volumes and enthalpies may be applied directly where it is desired to calculate differential changes resulting from the addition or removal of small quantities of a component in a solution. However, the principal reason for developing these relationships is their usefulness in the thermodynamic equations which govern vapor liquid equilibria at high pressures. These applications are discussed in a later paper.

Acknowledgments

The work herein reported was made possible by the financial support of the Wisconsin Alumni Research Foundation. The helpful suggestions of O. A. Hougen and the assistance of Roger P. Lescohier in the development of Fig. 1 are gratefully acknowledged.

Correction, Please

The third article of this series, in the July 5th issue of NPN's Technical Section (pp. R-476-484) was incorrectly titled. It should have read "Thermodynamic Properties of Organic Compounds—Estimation from Group Contributions" instead of "... from Group Concentrations".

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Nomenclature

H = Enthalpy
H = molal enthalpy
J = mechanical equivalent of heat
m = mass
n = number of moles
P = total pressure
p = pressure
R = gas constant
s = saturation value
T = absolute temperature
V = volume
v = molal volume
y = concentration in vapor phase (mole fraction)
z = compressibility factor
ρ = density
ω = liquid expansion factor
Λ = heat of vaporization
λ = molal heat of vaporization
$\psi = (J\rho_1/p_c\omega_1)\,(H_{c_p} - H)_T$
$\theta = (\mathrm{H}^\circ - \mathrm{H})/T$

Subscripts and Superscripts

A, B, C, ... = components comprising solution
c = critical property
cp = critical pressure
i = i'th component
l = liquid state
o = absolute zero
r = reduced state
t = total mass
1 = reference state
$'$ = pseudo property
$^\circ$ = ideal state

Coming Articles in Process Engineering Series

"High Pressure Vapor — Liquid Equilibria," by B. W. Gamson and K. M. Watson will be next in this series of articles dealing with the development of fundamental physical chemistry data required to properly design the modern refinery. It will appear in the Sept. 6 issue.

The paper will deal with an improved thermodynamic definition of the vaporization equilibrium constant, and the development of methods for deriving activity coefficients for rigorous vaporization equilibrium calculations as high pressures.

This series is being published exclusively in the Technical Section of National Petroleum News, and presents data which are the results of studies being conducted at the University of Wisconsin as part of a graduate research program in chemical engineering.

Three articles have already appeared. Subject of the first (May 3, pp. R-258-264) was "Vapor Pressures and Critical Properties of Organic Compounds." The second article (June 7, pp. R-372-375) dealt with "Thermal Properties of Hydrocarbons." The third appeared last month (July 5, pp. R-476-484) — "Thermodynamic Properties of Organic Compounds—Estimation from Group Contributions."

KEEPING UP WITH THE NEWS

New Developments in Scientific, Industrial and Economic Fields with Comment as to Their Possible Future Effect on the Petroleum Industry

*By N.P.N. Special Writer**

In keeping with the purpose announced in the first article in this series, subjects discussed this month pertain to problems and processes of direct interest to the petroleum industry. Many of these developments have already been reported in the news columns of NATIONAL PETROLEUM NEWS; but later consideration and published discussions concerning them have provided new material which may prove of aid to technologists in weighing their importance.**

The production and use of petroleum and its products are today fields of increasing complexity, hence it behooves each member of the industry to keep abreast of new developments along these lines.

The author of this series is a chemical engineer in the research subsidiary of one of the large oil companies; his work includes a study of current technical journals in many fields related to the petroleum industry.

Direct Fuel Injection

CONSIDERABLE INTEREST has already been evidenced in the announcement by the American Bosch Corp.[1] that it has perfected and is now producing direct-injection gasoline engines.

"Based on the method of direct fuel delivery employed in Diesel engines, gasoline injection differs from the conventional carburetor system in that air is not mixed with the gasoline until the fuel is injected into the engine cylinder. Atomization of the fuel is obtained by injecting it under pressure through a discharge nozzle. . . . ," it was stated.

"Higher efficiency even with lower-grade gasoline, greater responsiveness, smoother power delivery, and elimination of the fire hazard of an explosive gasoline-air mixture in the induction system are some of the advantages claimed for the new fuel distribution system."

Further attention has even more recently been focused on the subject of "Spark-Ignition Fuel Injection Engines for Ground Vehicles" by N. N. Tilley, chief engineer, special engine project, Studebaker Corp., at the National War Materiel Meeting of the Society of Automotive Engineers this June.[2]

According to Mr. Tilley, some of the advantages claimed for fuel injection systems versus most carburetor manifold systems are: equality of fuel distribution to each cylinder without preheated air; better atomization of the fuel through use of high-pressure discharge nozzles; freedom from icing; the ability to use a wider range of fuel volatility; the elimination (or at least great reduction) of backfiring; the possibility of two-cycle engines approaching four-cycle engines in efficiency; greater maximum power along with better fuel economy and greater operational smoothness; the possible use of lower-octane fuels or increased compression ratios or supercharged operation; easier starting and quicker warm-up; better acceleration and more flexible operation; and the elimination of exhaust odors during idling plus attendant fuel savings.

Against this imposing list of advantages, Mr. Tilley cited the following disadvantages: injection systems are generally more costly; reliability in service may not be as good; maintenance costs may be higher; more extensive filtration of the fuel is required; vapor lock cannot be as easily controlled; cylinder oil dilution must be provided for if low-volatility fuels are used; more attention is required to maintain the engine hot; and special attention must be given to other parts of the engine to realize the optimum results.

While the engines discussed above are of the spark-ignition types, it is of interest to note that gasoline may be used as a fuel in injection engines of the compression-ignition (Diesel) type. John Dickson of the General Motors Corp. recently stated[3] that "another development which has been born of necessity during the war relates to the preconceived line of demarkation between the gasoline and Diesel engine. We know that the gasoline engine has a compression ratio of, say, 5 to 6 to 1, whereas the Diesel engine has a ratio of 16 to 1, and that as we advance beyond 6 to 1 in the gasoline engine, anti-knock properties have been added to the gasoline to permit operation at high compression ratios. However, it has been found possible to inject gasoline in the same manner as Diesel fuel is injected in the Diesel engine; that is, into a 16 to 1 compression ratio, and obtain a normal engine both as regards sound and performance.

"As a matter of fact when the gasoline is injected into the hot air of the combustion space, ignition of the gasoline takes place more slowly than when Diesel fuel is injected. This is contrary to what might have been expected. Knowing gasoline to be such a volatile fuel, they visualized that the injection of gasoline into a 16 to 1 compression ratio would blow the heads off, but this is not so.

"Ordnance vehicles have been constructed and operated with two tanks, one containing gasoline and the other Diesel fuel, so that by turning a valve in the operator's compartment, the Diesel engine would operate on either gasoline or Diesel fuel.

"The economy in the consumption of gasoline, using it this way in the Diesel cylinder compared with the normal carburetor engine, could be shown by the figures of 10, 14, and 16 miles to the gallon; if 10 miles per gallon were the consumption with the carburetor engine, 14 miles per gallon for the gasoline injected into the Diesel cylinder, and, say, 16 miles per gallon for the straight Diesel."

It is not likely that dual-fuel or gasoline Diesel-cycle engines will find much use in the U. S. after the war, since Diesel oil may be expected to retain at least part of its present advantage in cost and to maintain

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(1) Anon., NATIONAL PETROLEUM NEWS 36, No. 19, 30 (1944), "New Gasoline Injection System Perfected For Postwar Motors."

*The author is a chemical engineer on the research staff of one of the oil companies.

**Technical Section, NATIONAL PETROLEUM NEWS, 36, No. 27, R-420, (1944).

(2) Anon., NATIONAL PETROLEUM NEWS 36, No. 24, 44 (1944), "Fuel Injection Principle for New Engine Designs Stirs Lively Discussion at S.A.E. Forum."

(3) Dickson, John, *Industry and Power* 46, No. 4, 71 (1944), "Postwar Trends in Diesel Power."

the edge given to it by its higher Btu content per gallon. For foreign trade, however, such engines have some possibilities.

Fuel injection engines in general, spark-ignition and compression-ignition alike, seem destined to play a negligible role, if any, in passenger cars of the predictable future. As one automotive engineer puts it, "they'd have a good chance if a cheap, light, reliable one could be developed," but no engine meeting these requirements has as yet appeared.

For aircraft uses, such engines have more immediate potentialities, but the same automotive engineer characterizes present ones as "too heavy" and states that very good carburctors have been developed. Fuel injection engines must be built with very close tolerances and, as stated, are not yet as rugged and reliable in operation as are most carburetor engines.

Advantages in economy, the use of a wider range of fuels, and lower octane requirements—the latter occasioned by the fact that the theoretical equality of fuel distribution to the cylinders eliminates the occurrence of too-lean mixtures in a few cylinders and thus equalizes octane requirements at a lower level than for carburetor fuel systems—may, however, win for the fuel-injection, spark-ignition engines of the oil-burning types a market "in rail cars, power shovels and air compressors". The gasoline-burning types may well find application in large trucks and buses, where operating economies counterbalance higher first cost and operating expenses.

It is not very likely that fuel-injection, spark ignition engines will soon, by their requirements, disturb the normal balance of petroleum products either as regards yields or quality. As the announcement by the American Bosch Corp. implies, however, they are already commercial entities and, as such, merit the attention of the petroleum industry as regards future developments.

° ° °

Catalytically-Cracked Fuel Oils

With the wartime attention of the petroleum industry chiefly focused upon such problems as aviation gasoline, butadiene for synthetic rubber, toluene for T.N.T., and a host of other problems of equal importance, a "sidelight" in the production of gasolines by catalytic cracking has gone almost unnoticed—catalytically-cracked fuel oils. A little attention has indeed been given to their suitability as Diesel fuels, but even this has been largely speculative.

The potential importance of catalytically-cracked fuel oils is large. As Moore and Elder recently stated[4], "the charging capacity of these (catalytic cracking) plants now installed, or under construction, is about 893,000 bbl. per calendar day, or 326,000,000 bbl. per year. This capacity represents 54% of the charge of all types of stocks to noncatalytic cracking units in 1940." The authors point out that "in noncatalytic cracking, the residue is a tar, while in catalytic cracking about 75% of the residue, or 37½% of the charge, can go into No. 2 furnace oil and the remainder, amounting to about 12½% of the charge, can be used as a cracking stock or put into residual fuel oil"; thus catalytic cracking generally increases the yield of distillate fuel oils while decreasing the yield of residuals. The authors also point out that the tendency toward "utilizing heavier portions of the crude for charging to cracking units" will "tend to reduce the total fuel supply," thus placing further emphasis on the future role of catalytically-cracked distillates.

There is a general impression that catalytically-cracked distillates may be more difficult to burn satisfactorily, but too little data have been made public to substantiate this completely. A recent study of 10 different catalytic distillate heating oils[5] indicated that few average conclusions could be reached, since the oils varied widely in characteristics. It was noted, however, that more air is required to burn these oils in pressure atomizing burners if excessive soot is to be avoided, since they are heavier and their combustion requires more oxygen. For best results, if oils of both catalytic and noncatalytic origin are used indiscriminately, burner settings to provide a little excess air over previous operations were recommended.

Much remains to be done in the way of drawing up suitable specifications for these oils, but standardization probably cannot be expected until after the war, when catalytic operations will become more stabilized. The 10 catalytic distillate heating oils previously mentioned[5] varied in viscosity from 16.0 to 35.0; in initial boiling point from 423°F. to 466°F.; in endpoint from 600°F. to 630°F.; in sulfur content from 0.39% to 2.30%; in pour point from —5°F. to 15°F.; in flash point from 192°F. to 230°F. and in aniline point from 79°F. to 133°F., showing such a wide range that no all-inclusive specifications seem possible at present.

Among other problems which need to be investigated are storage stability, color stabilization, sedimentation and sludge prevention, and various techniques for burning the catalytically-cracked fuel oils. Much more may be expected to be heard on these subjects before very long.

° ° °

Gasoline from Coal

Considerable attention in recent months has been focused upon the possibility of producing gasoline and other petroleum products from coal. There is absolutely no question of the *technical* feasibility of either coal hydrogenation or the Synthine (Fischer-Tropsch) process—despite the phrasing of the bill calling for the construction of several "demonstration" plants which recently passed Congress. What is in doubt are the present and potential economics of the processes and the question as to whether they can compete with crude petroleum in predictable future.

Before the war, it was not possible to judge accurately from German and British data which of the two processes, coal hydrogenation or Synthine process, offered the greatest potentialities. Germany, intent on preparation for war, constructed plant after plant using both, crystallizing in commercial practice technical developments which, under normal circumstances, would have been the subject for much further research, since plants using them could not compete economically on their own merits. Much the same situation prevailed in England, where the coal and tar hydrogenation plant at Billingham has proved a God-send for the production of aviation gasoline stock rather than a going commercial enterprise.

It would seem from testimony presented last fall before Senate subcommittee hearings on S.1243[6] and from more recent data that the burden of evidence indicates that for many purposes the Synthine process has several advantages. Capital investments required per daily barrel seem to be smaller—perhaps eventually on a par with modern petroleum processes, although now about twice as large (perhaps $6000 or more for

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[4] Moore, W. G. and Elder, T. G. NATIONAL PETROLEUM NEWS, TECHNICAL SECTION 36, No. 24, R-334 (1944), "Effect of Catalytic Cracking on the Postwar Supply of Motor Gasoline and Fuel Oils."

[5] Anon., *Fuel Oil and Oil Heat* 3, No. 2, 42 (1944), "Changing Fuel Oil Characteristics Discussed."

[6] "Synthetic Liquid Fuels," Hearings on S.1243, Aug. 3, 4, 6, 9, 11, 1943, Superintendent of Documents, Washington, 1943.

plants of present design using coke). Manpower requirements are definitely lower. Depending upon adaptations of the process, prices may be much lower—eventually competitive, perhaps, with gasoline from crude oil at $2 per barrel.

One very large advantage of the Synthine process is the recently-realized fact that almost any type of coal can be used in the synthesis, with varying yields, of course. It is technically possible to hydrogenate all grades of coal; but it is an unfortunate fact that many of the high-yielding ranks are the hardest, hence most expensive, to hydrogenate. The Synthine process as generally understood in the past[7], it is true, involves the preparation of the intermediate synthesis gas from the reaction of steam with coke from bituminous coal, the process being only a slight variation of the conventional water-gas synthesis; similar gases can be prepared from natural gas at considerably lower costs, but that must be disregarded in a discussion of synthesis from coal.

It is now known that the use of coke is not obligatory and that it probably will be possible to complete the development of a number of continuous processes for the gasification of noncoking coals such as subbituminous and lignite, thus not only eliminating expensive coking plants, but also providing for the use of much cheaper coals which at present have few economic uses.

Numerous patents on continuous gasification of coal already exist, and it has been reported that plants using some of the variations have been constructed in Germany. The exact influence of continuous gasification of coal upon the Synthine process is not determinable, since much research will be needed to realize indicated potentialities, but it is believed that, using this process, investment per daily barrel may be more than halved (perhaps lowered to $3000) and the cost of gasoline by this modification of the Synthine process may approach 8c per gal. This would compare, as mentioned, to gasoline from crude at $2 per barrel.

° ° °

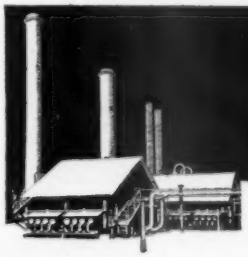
Postwar Refinery Construction

A recent letter[8] to "all petroleum refiners" from E. D. Cumming, PAW's refining director, is of definite im-

[7] Porter, H. C., *Chemical and Engineering News* 22, No. 11, 904 (1944), "Coal as an Auxiliary Source of Gasoline Supply."

[8] Anon., NATIONAL PETROLEUM NEWS 36, No. 26, 28 (1944), "PAW Invites All Petroleum Refiners in Nation to Chart Building Plans for Postwar Era."

Without fire the art of glass blowing would never have been discovered. The genesis of this important industry early in the Christian era was a vital contribution to civilization. Without fire, petroleum products in their unlimited variety would be nonexistent. For heating hydrocarbons efficiently and economically Alcorn heater installations have made a notable contribution to the industry. For 20 years Alcorn has devoted its entire energies to the scientific application of fire to the ever changing, increasingly complex demands for the processing of every type of petroleum product. Because of its long successful record, Alcorn merits consideration for the solution of your heating problem.



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portance to the petroleum refining industry in that it indicates that PAW is proposing to lend its aid in obtaining materials for refinery construction when the completion of wartime projects makes possible a relaxation of controls over materials and labor.

What is of more importance, however, is that this letter serves to remind the individual refiner that the postwar period will differ in equipment needs from the prewar and wartime eras and that, if the wartime construction programs have passed him by or left him less well equipped than his competitor, he should now prepare detailed plans for the future.

It is axiomatic that he whose plans are all ready to go will get materials first when they become generally available, for it is probable that fabricators of refinery equipment will be unable instantly to meet all the demands which will eventuate after the war.

PAW is not promising anything definite as to time in its program, but it is promising "to give first consideration, as to projects of a given type, to those which were first submitted in up-to-date detail." Submission of detailed plans, however, does not bind the refiner "to undertake construction, and the information submitted will be regarded as confidential."

Types of construction projects which at present appear particularly advantageous to PAW include those which would call for: (1) improvements in the quality and yields of products per barrel of crude, especially such products as aviation gasoline and lubricating oils; (2) the expansion of storage capacity; (3) the adaptation of equipment to process high-sulfur crudes; (4) the installation of research and development facilities; and (5) the installation of more efficient utilities and service units.

This program appears to offer many advantages to the refiners who participate and should serve as a spur to plans for the adjustment of refineries to meet postwar demands. It is designed to avoid any interference with the war effort, yet is intended to gain maximum speed for postwar refinery construction after wartime goals are met.

° ° °

The Wulff Process

A recent announcement, since branded as "premature," states that the Defense Supplies Corp. plans to construct a $9,000,000 plant to produce alcohol from "waste refinery gases" on the site of the Continental Oil Co.'s refinery at Lake Charles, La., the plant to be operated by Petroleum Chemicals, Inc. This last named is a jointly-owned subsidiary of Continental and U. S. Industrial Chemicals, Inc. (the latter being a subsidiary of the Air Reduction Co.).

It is now said that this plant has not yet been approved by WPB, although its construction is reported to have been recommended by the Office of Production Research and Development. The process to be used is said to involve the production of acetylene and ethylene by the use of a high-temperature cracking process, which is of added interest in that it indicates a probable extension in use of the Wulff regenerative furnace process, about which so much was heard in 1942 in connection with the same companies.

It was reported in that year that a cracking plant of this type was to be built by Petroleum Chemicals, Inc., at Baltimore, Maryland, and that another plant of the same size (150,000 pounds of acetylene per day) was being built in Texas by the Monsanto Chemical Co., with other plants of this type being planned[9]. The first plant, upon completion, was to have been operated experimentally for the development of information concerning the production of butadiene (yields of 5.2% from heavy naphthas

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[9] Raigorodsky, P. M. and Dotterweich, F. H., NATIONAL PETROLEUM NEWS, TECHNICAL SECTION 34, No. 47, R-420 (1942), "Importance of Natural Gasoline and Derivatives to Synthetic Rubber and Aviation Gasoline Programs."

Over 80 Petroleum Projects Included In Texas A. & M. Research Program

THE Department of Chemical Engineering at Agricultural & Mechanical College of Texas, College Station, is expanding its co-operative research projects with industrial organizations to develop petroleum and other natural resources in Texas through the application of chemical engineering.

Texas A. & M.'s program will divide the work into three phases, according to J. D. Lindsay, head of the department: (1) expansion of chemical engineering graduate instruction, (2) expansion of research work leading to M. S. and Ph.D. degrees in chemical engineering and (3) expansion of co-operative research projects with industrial organizations.

G. C. Kirkbride, petroleum technologist, will direct industrial research leading to graduate degrees in chemical engineering at Texas A. & M.

Research will be directed generally toward utilization of the State's many natural resources, with the major part devoted to more effective and economical utilization of petroleum and natural gas. More than 80 projects in this field alone have been outlined for investigation, most of them being financed on a co-operative basis by private companies through Texas Engineering Experiment Station, which involves establishment of graduate fellowships.

In line with the expanded petroleum program, G. C. Kirkbride has been appointed to the staff as a full professor; a considerable portion of his time will be devoted to supervision of the research projects. He received his training in chemical engineering at the University of Michigan, both B.S. and M.S. degrees being granted in 1930. Since graduation he was a chemical engineer in Standard Oil Co. (Ind.), Whiting, research department until 1934; assistant director of research for Pan American Refining Corp. at Texas City, Texas, from 1934 to 1942; and from 1942 until his appointment at Texas A. & M. he was chief of chemical engineering development, field research department, Magnolia Petroleum Co., Dallas.

Prof. Kirkbride's experience has included process design, technical service, pilot plant development and economic appraisals on heat transmission, distillation production of distillate fields, thermal cracking, catalytic cracking, alkylation, isomerization, polymerization and allied fields. He has had several papers published on heat-transfer of liquids and vapors, and also on high pressure absorption of light hydrocarbons, and one patent now pending on high-pressure absorption of gases from condensate fields.

being later reported).

Patents on this process are held by the Wulff Process Co. of Los Angeles, and development work was initiated by the Tennessee Eastman Corp. of Kingsport, Tenn., in 1934.

The Wulff process is unique in that it employs regenerative furnaces to obtain the temperature necessary to produce high yields of gaseous unsaturates.

Any process which produces such a high yield of unsaturated light hydrocarbons as does the Wulff process is of great interest for the manufacture of synthetic organic chemicals. Acetylene and ethylene, the major products of the Wulff process, are both parents to a wide range of chemicals, such as ethyl alcohol, acetic acid, ethylene glycol, butanol, vinyl chloride, and others.

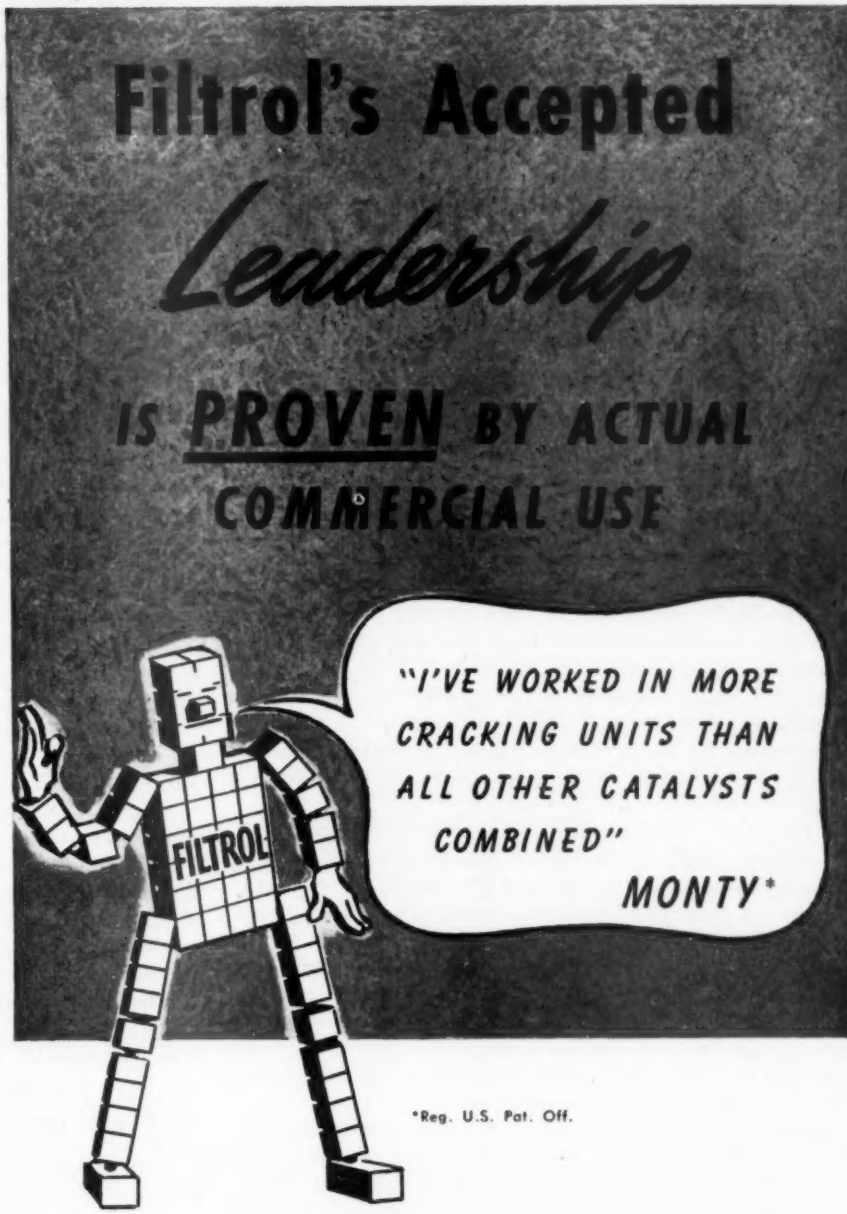
It is not possible to determine the present status and number of the plants announced in 1942 from published accounts, probably because censorship has restricted the publication of this information. Neither is it possible to determine exactly what are the costs of the gaseous unsaturates produced by this process, although costs of one to two cents per pound of acetylene were sought.

Advocates of the Wulff system believed in 1942 [10] that this process has considerable economic advantages over production of acetylene from hydrocarbons by use of the electric arc and the standard process of production from calcium carbide, which in turn requires much electrical energy for synthesis.

The present proposal for use of the Wulff process evidently regards the hydrolysis (in some manner) of the ethylene produced to yield ethyl alcohol. OPRD interest is indicative of that group's attention to processes which may augment the supply of alcohol, so vitally needed for war purposes such as the production of butadiene. If the proposed plant is built, it would seem to have excellent competitive possibilities for the postwar era—much better, certainly, than recent plants built to produce alcohol from wheat, and probably better than the plants being constructed to produce alcohol from wood wastes (discussed last month).

Petroleum has long seemed the most economic source of ethyl alcohol, which may be (and is) produced from it in several ways; i.e., ethylene may be obtained from cracked refinery gases or synthesized, after which several variations in hydrolysis processes are known to exist. The Wulff process would seem not only to be a good source of ethyl alcohol, but also to have ramifications in chemical manufacturing which extend far beyond it.

[10] Hasche, R. L., *Chemical & Metallurgical Engineering* 49, No. 7, 78 (1942), "Production of Acetylene by Thermal Cracking of Petroleum Hydrocarbons."



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WIDENING HORIZONS

Views on Personnel, Management and Economic as Well as Technological Developments in Petroleum Refining and Natural Gas Processing: Comment from Readers Is Invited

Motor Oils After the War For the Cars of the Future?

ALREADY considerable discussion has taken place in regard to postwar motor fuels; but what about the motor oils of the future and, more particularly, the qualification of heavy duty oils to meet the needs of the automotive engines that will be developed in peace times?

Requirements for which engine oils must now qualify to meet every extreme condition found in military operation of ground vehicles are, perhaps, more exacting than for their fuels and the lubricants have been improved to meet these conditions. How wartime developments will be adapted to meet the future requirements of peacetime service is a question to which technologists already are giving attention.

Authorities for the Gulf Research & Development Co. discuss this subject in an article in a recent issue of an English scientific journal.*

To meet the wartime military requirements, they point out, an oil must meet all the service conditions of all kinds of units, because the loss of one vehicle could, in theory at any rate, have a large influence on the course of a military action. Failure of a lubricant under these conditions could not be tolerated. Based upon this principle, Army Specification 2-104B has been set up as standard for all oils for all engines of Army ground vehicles, both Diesel and gasoline engines. An elaborate means of qualification has been provided to insure that the approved lubricants possess the properties to meet the most severe conditions that will be encountered.

"However logical this mode of thinking is for war," this article continues, "it may not be the wisest in adopting a permanent way of evaluating lubricants in peacetime. When war is done, the basic considerations of overall cost assert themselves, and the ideal becomes the greatest good for the greatest number at the smallest total expenditure of goods and labor.

A Peacetime Formula

"According to this ideal it may be best to undergo one failure of one eccentric freight transport truck so that 999 others may operate at maximum efficiency for the longest time. This statement is based on the idea that a product which functions satisfactorily under the most severe conditions of all the current units very probably will not, except by a happy accident, be the best oil for all or even for more than one of them.

"When an oil is compounded to reach a definite value of detergency, oxidation stability and freedom from depositing tendency, the chemist who makes it up has probably sacrificed a greater excellency in, say, wear resistance to attain the detergency required, and so on. Left unrestricted to develop an oil of high detergency for a certain engine and within certain cost limits, the chemist could do much better if he did not have to remember that at the same time he must maintain a certain level of freedom from bearing corrosion because the oil is to be used in another type of engine suffering from that complaint."

While average service for military duty must be defined as the sum of all the most severe conditions to be encountered in all types of power plants employed, such a concept is not practicable of adoption to meet the requirements of heavy-duty oils for peacetime service, these authorities believe.

"One type of engine may be a bad actor from the standpoint of bearing corrosion", they go on to say, "another develops a troublesome amount of varnish deposits, a third sticks too many rings, another has a bad record on oil economy and so on. To average all these would define a total condition which could be met by a rather mediocre oil which would not measure up satisfactorily under the typical severe running conditions of any one of the units included in the average."

Admitting that the wartime solution of one oil good enough for all types of engines, costly and uneconomical, is not the peacetime answer, these authorities do not have a ready way to meet the problem of qualifying heavy-duty oils for future commercial service. Their logical deduction—and they admit it is an unpleasant one—is a new engine test every time a new type of power plant comes on the market. This brings up the prospect of adding indefinitely to the number of test engines automotive laboratories would be required to set up. Gulf Research staff members suggest a prototype test engine, which could be adapted to duplicate the required operating conditions. The Gulf laboratories have had some experience with an engine of this type.

Problem for Technologists

This situation creates a very tangible problem for the oil company chemists and automotive engineers. Some have expressed the hope that, out of the accumulated wartime experience with additives and other factors in the development of heavy-duty engine oils, some means may be found for reducing the time required for engine runs and in other ways simplifying the qualification tests for the oils.

In defining peacetime service conditions for heavy-duty oils, the authorities quoted above very soundly have not included passenger-car service. They take the position that light passenger-car use cannot be defined as average service, at least until passenger-car engines are made lighter and are habitually operated under high-load conditions.

The average quality of all motor oils sold after the war will be higher because of technological improvements in their manufacture and as materials for additives which are now on the critical list become generally available. Also passenger cars, after the war, will continue to be operated under all kinds of conditions of their engines as regards wear, care and the presence of sludge, water and other contaminating substances in the crankcase. In view of these factors it would seem unnecessary to adopt elaborate conditions, costly to the oil company and the public, to check oils for passenger-cars against requirements that will be met in operation only to a very limited extent. The petroleum technologists should use their influence to see that the oil company sales departments do not demand such requirements as talking points for their individual brands of oils.

*"Some Ideas About Correlation of Test-Engine Results", by T. P. Sands, C. J. Livingstone and W. A. Gruse, Gulf Research and Development Co. and Mellon Institute of Industrial Research, Journal of Institute of Petroleum, March, 1944.

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